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Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wisc., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

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Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

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Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

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Thirty-seventh Annual Meeting, Washington, D. C., Dec. 31, 1924–Jan. 3, 1925. President, A. F. Burgess; First Vice-President, M. C. Tanquary; Second Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

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Becker, G. G., P. Q. C. A., Washington, D. C.
Beckwith, C. S., Cranberry Exp. Sta., Pemberton, N. J.
Bedford, Theo., Welcome Tropical Research Lab., Khartum, Sudan.
†Bentley, G. M., University of Tennessee, Knoxville, Tenn.
†Berger, E. W., Box 656, Gainesville, Fla.
†Berley, J. A., Clemson College, S. C.
Bethune, C. J. S., Guelph, Ontario, Canada.
Bibby, F. F. Div. of Entomology, College Station, Texas.
Bigger, J. H., 1114 So. Main St., Jacksonville, Ill.
†Bilsing, S. W., College Station, Texas.

†Members who attended 1930 meeting.

†Bishopp, F. C., U. S. Bureau of Entomology, Washington, D. C.
Blackman, M. W., Bureau of Entomology, Washington, D. C.
Blanchard, R. A., 600 26th St., Sacramento, Calif.
Bliss, C. I., 724 Earlham Drive, Whittier, Calif.
Bondy, Floyd F., Box. 65, Florence, S. C.
Bourne, A. I., Agr. Exp. Station, Amherst, Mass.
Boyce, A. M., Citrus Experiment Station, Riverside, Calif.
Boyd, M. F., 910 Fairview St., Jackson, Miss.
Boyden, B. L., Indio, Calif.
Bradley, G. H., Mound Laboratory, Mound, La.
Brannon, C. H., State College, Raleigh, N. C.
Brannon, L. W., 151 W. 11th Ave., Columbus, Ohio.
Brimley, C. S., Department of Agriculture, Raleigh, N. C.
Brittain, W. H., MacDonald College, Quebec, Canada.
†Britton, W. E., Agr. Exp. Station, New Haven, Conn.
Broadbent, B. M., 724 Earlham Drive, Whittier, Calif.
†Bromley, S. W., Bartlett Research Lab., Stamford, Conn.
Brooks, F. E., U. S. Bureau of Entomology, French Creek, W. Va.
Brown, Luther, Silver Spring, Md.
Brues, C. T., Zoological. Lab., Harvard University, Cambridge, Mass.
Bruner, Lawrence, 3033 Deakin St., Berkeley, Calif.
Bryson, Harry R., K. S. A. C., Manhattan, Kansas.
Bulger, J. W., Bureau of Entomology, Washington, D. C.
Burdette, R. C., Agr. Exp. Sta., New Brunswick, N. J.
†*Burgess, A. F., 964 Main St., Melrose Highlands, Mass.
Burke, H. E., 1551 Emerson St., Palo Alto, Calif.
Burrell, R. W., 70 Groveland St., Abington, Mass.
Burrill, A. C., Missouri Resources Museum Com., Jefferson City, Mo.
Busck, August, U. S. National Museum, Washington, D. C.
Butler, H. G., 909 Crescent St., Harriman, Tenn.
Buys, John L., St. Lawrence University, Canton, N. Y.

Caesar, Lawson, Ontario Agricultural College, Guelph, Canada.
Caffrey, D. J., 615 Front St., Toledo, Ohio.
Cagle, L. R., Experiment Station, Blacksburg, Va.
†Campbell, F. L., 7710 Blair Rd., Takoma Park, Md.
Campbell, R. E., Box. 297, Alhambra, Calif.
Carter, Walter, University of Hawaii, Honolulu, H. T.
Cartwright, W. B., 600 26th St., Sacramento, Calif.
Cassidy, T. B., Box 1896, Tucson, Ariz.
Caudell, A. N., U. S. National Museum, Washington, D. C.
Cecil, Rodney, Box 297, Alhambra, Calif.
Chamberlin, F. S., Box 239, Quincy, Fla.
Chamberlin, T. R., Forest Grove, Ore.
†Chambers, E. L., State Entomologist's Office. Madison, Wisc.
Chandler, S. C., Route 5, Carbondale, Ill.
†Chapman, P. J., Experiment Station, Geneva, N. Y.
Chapman, R. N., University of Hawaii, Honolulu, H. T.

†Members who attended 1930 meeting.
*Life member.

Childs, Leroy, Hood River, Ore.
†Claassen, P. W., 102 Irving Place, Ithaca, N. Y.
Clausen, C. P., Bureau of Entomology, Washington, D. C.
†Cleveland, C. R., 910 S. Michigan Ave., Chicago, Ill.
Coad, B. R., U. S. Bureau of Entomology, Tallulah, La.
Cockerell, T. D. A., 809 Tenth St., Boulder, Colo.
Cockerham, K. L., Box 205, Biloxi, Miss.
Coe, Wesley R., Yale University, New Haven, Conn.
Colcord, Mabel, Bureau of Entomology, Washington, D. C.
Cole, F. R., U. S. D. A. Lab., Whittier, Calif.
Collins, C. W., U. S. Bureau of Entomology, Melrose Hlds., Mass.
Compton, C. C., 614 S. State Rd., Arlington Heights, Ill.
Comstock, J. H., Cornell Univ. Ithaca, N. Y.
†Cook, Mel T., Insular Exp. Station, Rio Piedras, P. R.
Cook, William C., Box 488, Davis, Calif.
Cooley, Charles C., 733 Richmond Ave., Silver Spring, Md.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Corkins, C. L., University of Wyoming, Laramie, Wyo.
†Cory, E. N., Agricultural Experiment Station, College Park, Md.
†Cotton, E. C., Depart. of Agriculture, Columbus, Ohio.
Cotton, R. T., Bureau of Entomology, Washington, D. C.
Craighead, F. C., Bureau of Entomology, Washington, D. C.
Crampton, G. C., Agricultural College, Amherst, Mass.
†Crawford, H. G., Entomological Branch, Ottawa, Can.
Creel, C. W., University of Nevada, Reno, Nev.
Criddle, Norman, Treesbank, Manitoba, Can.
Crosby, C. R., Cornell University, Ithaca, N. Y.
Crossman, S. S., 964 Main St., Melrose Highlands, Mass.
Crumb, S. E., Box 233, Puyallup, Wash.
†Cutright, C. R., Agricultural Experiment Station, Wooster, Ohio.

Dampf, Alfons, Avenida Insurgentes, 171, Mexico, D. F., Mexico.
Daniel, D. M., Experiment Station , Geneva, N. Y.
Davidson, William, R. F. D. No. 1, Silver Spring, Md.
Davis, A. C., Box 35, Santa Ana, Calif.
Davis, E. W., 601 McCormick Bldg., Salt Lake City, Utah.
†Davis, J. J., Agricultural Experiment Station, Lafayette, Ind.
Dean, George A., Kansas State Agricultural College, Manhattan, Kan.
Deay, Howard, Purdue University, Lafayette, Ind.
†Decker, George C., Iowa State College, Ames, Iowa.
DeCoursey, R. M., Conn. Agr. Coll., Storrs, Conn.
†DeLong, Dwight M., Ohio State University, Columbus, Ohio.
De Ong, E. R., Mills Bldg., San Francisco, Calif.
†Detwiler, J. D., 844 Hellmuth Ave., London, Ontario
†Dietz, H. F., Depart. of Entomology, State University, Columbus, Ohio.
Doane, R. W., Stanford University, Calif.
Dodds, Clifford T., 429 No. 8th St., Santa Paula, Calif.
Dohanian, S. M., 42 Cedar St., Somerville, Mass.
Doucette, C. F., Box 566, Sumner, Wash.
Douglas, J. R., Box 353, Estancia, New Mexico.

†Members who attended 1930 meeting.

Dowden, P. B., Kapy utca 21, Budapest II, Hungary
Downes, W., Dominion Entomologist Lab., Dept. Agr., Victoria, B. C.
Dozier, H. L., Service Technique, Port au Prince, Haiti.
†Drake, C. J., Iowa State College, Ames, Iowa.
†Driggers, B. F., Agr. Exp. Station, New Brunswick, N. J.
Dudley, J. E., Jr., Exp. Station, Madison, Wisc.
Dunavan, David, Clemson College, S. C.
†Dunham, W. E., O. S. U., Columbus, Ohio.
Dunnam, E. W., Box 750, Bryan, Texas.
†Dusham, E. H., College Heights, State College, Pa.
Dustan, A. G., Entomological Branch, Ottawa, Canada.

†Eckert, J. E., Bee Culture Field Station, Laramie, Wyo.
†Eddy, C. O., Kentucky Experiment Station, Lexington, Ky.
Ellington, G. W., Silver Spring, Md.
English, Lester L., Spring Hill, Ala.
Elmore, J. C., Box 35, Santa Ana, Calif.
Essig, E. O., University of California, Berkeley, Calif.
Evenden, J. C., Coeur D'Alene, Idaho.
Ewing, H. E., U. S. National Museum, Washington, D. C.
Ewing, K. P., Tallulah, La.
Eyer, J. R., Depart. of Biology, State College, New Mexico.

Fackler, H. L., Knoxville, Tenn.
Faxon, Richard, Box 991 San Juan, P. R.
†Felt, E. P., Bartlett Res. Lab., Stamford, Conn.
Fenton, F. A., Sta. A., Box 67, El Paso, Texas.
Fernald, H. T., 707 E. Concord Ave., Orlando, Fla.
Ferris, G. F., Stanford University, Calif.
†Ficht, G. A., Purdue University Exp. Sta., W. Lafayette, Ind.
†Filinger, G. A., Ohio Agr. Exp. Station, Wooster, Ohio.
Fink, D. E., Biology Dept., Univ. of Penn., Philadelphia, Pa.
Fisher, C. K., Box 24, Modesto, Calif.
Fisher, W. S., U. S. National Museum, Washington, D. C.
Flanders, S. E., Calif. Citrus Exp. Sta., Riverside, Calif.
Flebut, A. J., c/o General Chem. Co., 201 Sansome St., San Francisco, Calif.
Fleming, W. E., Box H, Moorestown, N. J.
Fletcher, R. K., Box 152 Faculty Exchange, College Station, Texas.
Fleury, A. C., c/o State Dept. of Agr., Sacramento, Calif.
†Flint, W. P., 1006 S. Orchard St., Urbana, Ill.
†Fluke, C. L., University of Wisconsin, Madison, Wisc.
Folsom, J. W., Tallulah, La.
Ford, A. L., Extension Division, Brookings, S. D.
Ford, M. H., 503 Rio Grande National Life Bldg., Harlingen, Texas.
Fox, Henry, Box H, Moorestown, N. J.
Fracker, S. B., 3716 Ingomar St., N. W., Washington, D. C.
Franklin, H. J., East Wareham, Mass.
Freeborn, S. B., University of California, Davis, Calif.
Friend, R. B., Agr. Exp. Sta., New Haven, Conn.
†Frison, T. H., Dept. Ent., Natural History Bldg., Urbana, Ill.
Frost, S. W., Research Lab., Arendtsville, Pa.

†Members who attended 1930 meeting.

Fullaway, D. T., Agr. Exp. Station, Honolulu, H. T.
Fulton B. B., N. C. State Col., Raleigh, N. C.

Gahm, O. E., 119 W. Dean St., West Chester, Pa.
Gaines, J. C., Jr., Dept. of Entomology, College Station, Texas.
Gaines, R. C., Tallulah, La.
†Gambrell, F. L., Experiment Station, Geneva, N. Y.
Gardner, Theo. R., Box H, Moorestown, N. J.
Garman, H., 638 So. Limestone St., Lexington, Ky.
†Garman, Philip, Agricultural Experiment Station, New Haven, Conn.
Gentner, L. G., Box 877, Medford, Oregon.
†Gibson, Arthur, Entomological Branch, Ottawa, Canada.
Gill, J. B., Box 444, Albany, Ga.
Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
Gilmore, J. U., Box 346, Clarksville, Tenn.
Ginsburg, J. M., Agricultural Experiment Station, New Brunswick, N. J.
†Glasgow, Hugh, Agr. Exp. Sta., Geneva, N. Y.
Glasgow, R. D., Albany, N. Y.
†Glenn, P. A., Office of State Entomologist, Urbana, Ill.
Goodwin, James C., Gainesville, Fla.
†Goodwin, W. H., Box 5, North Lima, Ohio.
Graf, J. E., Bureau of Entomology, Washington, D. C.
Graham, S. A., School of Forestry & Conservation, U. of Michigan, Ann Arbor, Mich.
†Granovsky, A. A., University Farm, St. Paul, Minn.
Gray, G. P., c/o Amer. Cyanamid Co., Azusa, Calif.
Gray, H. E., University Farm, St. Paul, Minn.
†Griswold, Grace Hall, Dept. Ent., Cornell Univ., Ithaca, N. Y.
Grossman, E. F., Box 537, Gainesville, Fla.
†Gui, H. L., Agr. Exp. Sta., Wooster, Ohio.
Guyton, F. E., 110 Miller Ave., Auburn, Ala.
†Guyton, T. L., Bureau of Plant Industry, Harrisburg, Pa.

†Haack, T. T., 174 E. Long St., Columbus, Ohio.
Haber, V. R., Penn. State College, State College, Pa.
Hadley, C. H., Box H. Moorestown, N. J.
Haegele, R. W., Parma, Idaho.
Haeussler, G. J., Villa Mon Toit Chenin du Tamisier, Antibes, Alps Maritimes, France.
Hagan, H. R., Wahiawa via Honolulu, H. T.
Haley, W. E., 8203 Oak St., New Orleans, La.
Hall, M. C., Division of Zoology, Bureau Animal Industry, Washington, D. C.
Hallock, H. C., Westbury, Long Island, N. Y.
Hambleton, J. I., 423 Dorset Ave., Chevy Chase, Washington, D. C.
Hamilton, C. C., Rutgers College, New Brunswick, N. J.
Hamlin, J. C., 473 Fourth Ave., Salt Lake City, Utah.
†Hamner, A. L., A. & M. College, Miss.
Hargraves, Ernest, Land & Forest Dept., Freetown, Sierra Leone, W. Africa.
Harman, S. W., Exp. Sta., Geneva, N. Y.
†*Harned, R. W., A. & M. College, Miss.

†Members who attended 1930 meeting.
*Life member.

†Harris, H. M., Zool. Dept. I. S. C., Ames, Iowa.
Hartzell, Albert, Boyce Thompson Inst., 1086 No. Broadway, Yonkers, N. Y.
†Hartzell, F. Z., Agr. Exp. Station, Geneva, N. Y.
†Haseman, Leonard, Agr. Exp. Station, Columbia, Mo.
Hawley, I. M., 473 Fourth Ave., Salt Lake City, Utah.
†Hayes, W. P., Dept. of Ent., University of Ill., Urbana, Ill.
†Headlee, T. J., Agr. Exp. Station, New Brunswick, N. J.
Henderson, C. F., 222 6th Ave., E. Twin Falls, Idaho.
Herbert, F. B., Los Gatos, Calif.
Herms, W. B., University of Calif., Berkeley, Calif.
†Herrick, Glenn W., Cornell University, Ithaca, N. Y.
†Hervey, G. E. R., Experiment Station, Texas.
Hester, J. G., Box 597, Agricultural College, Miss.
High, M. M., Box 989, Gulfport, Miss.
Hill, C. C., 227 Moreland Ave., Carlisle, Pa.
†Hinds, W. E., Louisiana State Univ., Baton Rouge, La.
†Hodgkiss, H. E., Old Exp. Stat. Bldg., State College, Pa.
Hoerner, John L., Agricultural Experiment Station, Ft. Collins, Colo.
Hoffman, William A., School of Tropical Medicine, San Juan, P. R.
†Hoffmann, W. E., Lingnan University, 150-5th Ave., New York, N. Y.
†Holland, W. J., Carnegie Museum, Pittsburgh, Pa.
Holloway, J. K., Box H, Moorestown, N. J.
Holloway, T. E., 8203 Oak St., New Orleans, La.
Hood, C. E., U. S. Bureau of Entomology, Melrose Hlds., Mass.
Hooker, W. A., States Relation Service, Washington, D. C.
†Horsfall, J. L., 535 5th Ave., New York, N. Y.
Horton, J. R., 126 So. Minneapolis Ave., Wichita, Kan.
Hottes, F. C., 707 No. 7th St., Grand Jct. Colo.
†Hough, W. S., 515 Fairmount Ave., Winchester, Va.
Houghton, C. O., Agricultural Experiment Station, Newark, Del.
†Houser, J. S., Agr. Exp. Station, Wooster, Ohio.
Howard, L. O., U. S. Bureau of Entomology, Washington, D. C.
†Howard, Neale F., 151 West Eleventh Ave., Columbus, Ohio.
Howell, P. A., 615 Front St., Toledo, Ohio.
†Huber, L. L., Experiment Station, Wooster, Ohio.
Huckett, H. C., R. F. D., Calverton, N. Y.
†Hungerford, H. B., University of Kansas, Lawrence, Kansas.
Hunter, S. J., Univ. of Kansas, Lawrence, Kansas.
Hutson, J. C., Royal Botanic Gardens, Peradeniya, Ceylon.
†Hutson, Ray, State College, East Lansing, Mich.
†Hyslop, J. A., U. S. Bureau of Entomology, Washington, D. C.

Illingworth, J. F., Bishop Museum, Honolulu, H. T.
Ingram, J. W., Houma, La.
Isley, Dwight, 3 N. Duncan St., Fayetteville, Ark.

Jacobson, W. C., 1341 43rd Street, Sacramento, Calif.
Jaenicke, Alex. J., U. S. Forest Service, Portland, Ore.
Jaynes, H. A., Casilla Correo, 307, Trujillo, Peru, S. A.
Jewett, H. H., Agr. Exp. Station, Lexington, Ky.
†Johannsen, O. A., Box 48, College of Agriculture, Ithaca, N. Y.

†Members who attended 1930 meeting.

Johnson, H. B., Wellcome Laboratories, Khartoum, Sudan.
Jones, C. R., Agricultural College, Fort Collins, Colo.
Jones, D. W., U. S. Bureau of Entomology, Arlington, Mass.
†Jones, M. P., U. S. Bureau of Entomology, Washington, D. C.
Jones, P. R., Apart. 102, 100 Kenmore No., Los Angeles, Calif.
Jones, T. H., U. S. Bureau of Entomology, Melrose Hlds., Mass.

Keen, F. P., 501 Lewis Bldg., Portland, Oregon.
Keenan, W. N., Entomological Branch, Ottawa, Canada.
Kellogg, V. L., National Research Council, 21 and B Sts., Washington, D. C.
Kelly, E. G., Agricultural College, Manhattan, Kan.
†Kelsheimer, E. G., Oak Harbor, Ohio.
Kennedy, C. H., Ohio State University, Columbus, Ohio.
Kimball, H. H., Box 2080, Orlando, Fla.
Kincaid, Trevor, University of Washington, Seattle, Wash.
†King, J. L., Box H, Moorestown, N. J.
King, K. M., Entomological Laboratory, Saskatoon, Sask., Canada.
King, W. V., Bureau of Science, Manila, P. I.
Kinsley, A. C., University of Indiana, Bloomington, Ind.
Kirk, H. B., 1902 North St., Harrisburg, Pa.
†Kisliuk, Max, 134 S. 2d St., Philadelphia, Pa.
Knight, H. H., Iowa State College, Ames, Iowa.
†Knowlton, G. F., Utah Experiment Station, Logan, Utah.
Knull, J. N., Forest Research Institute, Mont Alto, Pa.

Laake, E. W., Entomological Dept., State College, Ames, Iowa.
Lamson, G. H., Jr., Agricultural College, Storrs, Conn.
Lane, Merton C., Box 616, Walla Walla, Wash.
†Langford, G. S., Univ. Md., College Park, Md.
Langston, J. M., Agricultural College, Miss.
†Larrimer, W. H., U. S. Bureau of Entomology, Washington, D. C.
Larson, A. O., 602 N. 9th St., Corvallis, Oregon.
†Lathrop, F. H., Box 167, Vincennes, Ind.
Lauderdale, J. L., Box 368 Yuma, Ariz.
Lawson, P. B., 635 Main St., Lawrence, Kansas.
Leach, B. R., Box H, Moorestown, N. J.
†Leiby, R. W., Dept. of Agriculture, Raleigh, N. C.
†Leonard, M. D., Insular Experiment Station, Rio Piedras, Porto Rico.
Lewis, H. C., Fruit Growers Exchange, Los Angeles, Calif.
Lipp, J. W., 8316 Cadwalader Rd., Elkins Park, Pa.
List, G. M., Agricultural College, Fort Collins, Colo.
Little, V. A., Box 225, Main Bldg., College Station, Texas.
Lockwood, Stewart, State Dept. Agriculture, Sacramento, Calif.
Loftin, U. C., Central Baraguay, Prov. de Camaguey, Cuba.
Lowry, Philip R., University of New Hampshire, Durham, N. H.
†Luginbill, Philip, Box 359, Monroe, Mich.
†Lyle, Clay, A. & M. College, Miss.

MacAloney, H. J., Northeast Forest Experiment Station, Amherst, Mass.
Mackie, D. B., State Insectary, Sacramento, Calif.
MacLeod, G. F., Roberts Hall, Cornell University, Ithaca, N. Y.

†Members who attended 1930 meeting.

Maheux, George, Department of Agriculture, Quebec, Canada.
†Manter, J. A., Connecticut Agr. College, Storrs, Conn.
†Marcovitch, S., University Farm, Knoxville, Tenn.
†*Marlatt, C. L., U. S. Bureau of Entomology, Washington, D. C.
Mason, A. C., Box 340, Honolulu, H. T.
Mason, P. W., Bureau of Entomology, Washington, D. C.
Matheson, Robert, Cornell University, Ithaca, N. Y.
Mathewson, A. A., Box 1077, San Antonio, Texas.
Maxson, Asa G., Longmont, Colo.
McBride, O. G., Box 491, Orlando, Fla.
McClendon, S. E., 212 South Hansell St., Thomasville, Ga.
McConnell, H. S., College Park, Maryland.
McDaniel, Eugenia, Agricultural College, East Lansing, Mich.
McDonough, F. L., Niagara Sprayer Co., Middleport, N. Y.
McGehee, T. F., Holly Springs, Miss.
†McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D. C.
McIntyre, H. L., Conservation Commission, Albany, N. Y.
McKinney, K. B., Box 346, Clarksville, Tenn.
†McLaine, L. S., Entomological Branch, Ottawa, Can.
McLean, R. R., County Bldg., San Diego, Calif.
McPhail, Miyanoato, Box 491, Orlando, Fla.
†Melander, A. L., College of the City of New York, N. Y.
Merrill, G. B., Gainesville, Fla.
Merrill, J. H., Raynham Center, Mass.
†Metcalf, C. L., University of Illinois, Urbana, Ill.
Metcalf, Z. P., Agr. Exp. Station, West Raleigh, N. C.
Metzger, F. W., Box H, Moorestown, N. J.
Mickel, C. E., University Farm, St. Paul, Minn.
Millen, F. E., Department of Apiculture, Guelph, Canada.
Miller, A. E., North Maple Ave., Zanesville, Ohio.
Miller, D. F., Ohio State Univ., Columbus, Ohio.
†Miller, R. L., Box 491, Orlando, Florida.
Milum, V. G., 104 Vivarium Bldg., Champaign, Ill.
Mitchell, T. B., State College, Raleigh, N. C.
Mitchener, A. V., Manitoba Agr. College, Winnipeg, Canada.
Montgomery, J. H., State Plant Board, Gainesville, Fla.
Moore, William, c/o American Cyanamid Co., 511 5th Ave., New York, N. Y.
Morgan, H. A., Agr. Exp. Station, Knoxville, Tenn.
†Morrill, A. W., 1505 Winchester Ave., Glendale, Calif.
Morrison, Harold, U. S. Bureau of Entomology, Washington, D. C.
Morse, A. P., Wellesley, Mass.
Mosher, Edna, Adelphi College, Garden City, N. Y.
Mote, D. C., Oregon Agr. College, Corvallis, Ore.
Moulton, Dudley, 244 California St., San Francisco, Calif.
Moznette, G. F., Box 482, Albany, Ga.
Muesebeck, C. F. W., U. S. Bureau of Entomology, Melrose Hlds., Mass.
Munro, J. A., State College, Fargo, N. D.

†Neiswander, C. R., Oak Harbor, Ohio.
†Neiswander, R. B., Ent. Dept., Experiment Station, Wooster, Ohio.

†Members who attended 1930 meeting.
*Life member.

Nelson, J. A., Mt. Vernon, Ohio.
†Ness, Henry, 821 Kellogg St., Ames, Iowa.
Neuls, J. D., 337 N. Santonio Ave., Ontario, Calif.
Newcomer, E. J., Box 243, Yakima, Wash.
Newell, Wilmon, State Plant Commission, Gainesville, Fla.
Nichol, A. A., Agr. Exp. Station, Tucson, Ariz.
Nickels, C. B., Box 209, Brownwood, Texas.
Noble, W. B., Box 495, West Lafayette, Ind.
Nolan, Willis J., 507 Cumberland Ave., Chevy Chase Sta., Washington, D. C.
Nougaret, R. L., 451 Woodbine St., Riverside, Calif.

†O'Kane, W. C., Agr. Exp. Station, Durham, N. H.
†Osborn, Herbert, Ohio State Univ., Columbus, Ohio.
Osborn, H. T., Box 208, Central Aguirre, Porto Rico.
Osborn, M. R., Box H, Moorestown, N. J.
Osburn, Raymond C., Ohio State University, Columbus, Ohio.
Osgood, W. A., New Hampshire Univ., Durham, N. H.
Owen, W. L., Jr., College Station, Texas.
Ozburn, R. H., Department of Entomology, Guelph, Ont.

†Packard, C. M., Box 495, West Lafayette, Ind.
Paddock, F. B., 535 Hayward Ave., Ames, Iowa.
Painter, H. R., Box 495, West Lafayette, Ind.
Painter, Reginald, H., K. S. A. C., Manhattan, Kans.
Park, O. W., Science Bldg., Ames, Iowa.
Parker, H. L., Le Mont Fenouillet, Hyeres, Var, France.
Parker, J. B., 1217 Lawrence St., N. E., Washington, D. C.
Parker, J. R., Agr. Exp. Station, Bozeman, Montana.
†Parker, Ralph L., K. S. A. C., Manhattan, Kans.
†Parker, R. R., U. S. Public Health Service, Hamilton, Mont.
Parker, W. B., Cal. Spray Chemical Co., Placerville, Calif.
Parks, H. B., Route E., Box 368, San Antonio, Texas
†Parks, T. H., Dept. of Ent. and Zool., Ohio State University, Columbus, Ohio.
Parman, D. C., Box 509, Uvalde, Texas.
†Parrott, P. J., Agr. Exp. Station, Geneva, N. Y.
†*Patch, Edith M., Experiment Station, Orono, Me.
†Patch, L. H., Box 976, Sandusky, Ohio.
†Peairs, L. M., Agr. Exp. Station, Morgantown, W. Va.
Pierson, H. B., Dept. Forestry, Augusta, Me.
Pellett, F. C., Hamilton, Ill.
Pemberton, C. E., Hawaiian Sugar Planters' Exp. Station, Honolulu, H. T.
Penny, D. D., Box 383, Ontario, Calif.
†Pepper, J. O., 603 East King St., Chambersburg, Pa.
Peters, H. S., Bur. Ent., Washington, D. C.
†Peterson, Alvah, O. S. U., Columbus, Ohio.
†Pettit, R. H., Agr. Exp. Station, East Lansing, Mich.
†Phillips, E. F. Cornell Univer., Ithaca, N. Y.
Phillips, W. J., U. S. Bureau of Entomology, Charlottesville, Va.
Phipps, Clarence R., Experiment Station, Orono, Me.
Pierce, W. D., 1531 S. 19 St., Lincoln, Nebr.

†Members who attended 1930 meeting.
*Life member.

Plank, H. K., Central Baragua, Prov. Camaguey, Cuba.
†Polivka, J. B., Oak Harbor, Ohio.
†Poos, F. W., Arlington Farms, Rosslyn, Va.
†Porter, B. A., Bureau of Entomology, Washington, D. C.
Potts, S. F., Bur. of Entomology, Melrose Hlds., Mass.
†Price, W. A., Agr. Exp. Sta., Lexington, Ky.

Quaintance, A. L., U. S. Bureau of Entomology, Washington, D. C.
†Quayle, H. J., University of California, Riverside, Calif.

†Rea, G. H., Reynoldsville, Pa.
Readio, Philip A., University of Kansas, Lawrence, Kansas.
†Reed, W. D., 515 Jefferson St., Danville, Va.
†Reese, C. A., Dept. Agr., Columbus, Ohio.
Reeves, George I., 473 4th Ave., Salt Lake City, Utah.
Regan, W. S., Calif. Spray Chemical Co., Yakima, Wash.
Reid, W. J., U. S. Bureau of Entomology, Chadbourn, N. C.
†Reinhard, H. J., Agr. Exp. Sta., College Station, Texas.
†Ressler, I. L., 10 E. 40th St., New York, N. Y.
†Richardson, C. H., Iowa State College, Ames, Ia.
Richmond, E. A., 39 Newbury St., Brockton, Mass.
†Riley, Harland K., Experiment Station, W. Lafayette, Ind.
†Riley, W. A., Univ. of Minn., Minneapolis, Minn.
†Roark, R. C., Bur. of Chem., U. S. D. A., Washington, D. C.
Robinson, J. M., Experiment Sta., Box 264, Auburn, Ala.
Robinson, R. H., Science Hall, Corvallis, Oregon.
Robinson, William, 5718 Kenwood Ave., Chicago, Ill.
Rockwood, L. P., U. S. Bureau of Entomology, Forest Grove, Ore.
†Rohwer, S. A., Plant Quarantine & Control Admin., Washington, D. C.
Rosewall, O. W., State Univ., Baton Rouge, La.
Ross, W. A., Vineland Station, Ontario, Canada.
Rude, C. S., Tlahualilo, Durango, Mexico.
Ruffin, W. A., Box 247, Auburn, Ala.
†Ruggles, A. G., University Farm, St. Paul, Minn.
Rumsey, W. E., Agr. Exp. Station, Morgantown, W. Va.
†Runner, G. A., U. S. Ent. Lab., Sandusky, Ohio.
Ryan, H. J., 330 No. Broadway, Los Angeles, Calif.

†Safro, V. I., c/o Kay Lab., Inc., 180 Madison Ave., New York, N. Y.
Sanders, G. E., c/o Ansbacher Chemical Co., 50 Union Sq., New York, N. Y.
†Sanders, J. G., c/o Sun Oil Co., Philadelphia, Pa.
†Sanders, P. D., College Park, Md.
†Sanderson, E. D., Cornell University, Ithaca, N. Y.
Sanford, H. L., Plant Quarantine & Control Admin., Washington, D. C.
†Sasscer, E. R., Plant Quarantine & Control Admin., Washington, D. C.
Satterthwait, A. F., 527 Ivanhoe Place, Webster Groves, Mo.
Sazama, Robert F., Entomological Lab., Vincennes, Ind.
Scammell, H. B., Toms River, N. J.
†Schlosberg, Morris, 615 Front St., Toledo, Ohio.
†Schoene, W. J., Agr. Exp. Station, Blacksburg, Va.
Schweiss, G. G., State Quarantine Office, Reno, Nevada.
Scullen, H. A., Agr. College, Corvallis, Ore.

†Members who attended 1930 meeting.

Seamans, H. L., Ent. Lab., Lethbridge, Alberta, Canada.
Searles, E. M., 1532 University Ave., Madison, Wisc.
†Sechrist, E. L., 423 Dorset Ave., Chevy Chase, Washington, D. C.
Severin, H. C., Agricultural Experiment Station, Brookings, S. D.
Severin, H. H., College of Agr., Univ. of Calif., Berkeley, Calif.
Shafer, G. D., 321 Melville Ave., Palo Alto, Calif.
†Shelford, V. E., Vivarium Bldg., Univ. of Illinois, Champaign, Ill.
Sheppard, R. W., P. O. Box 35, Niagara Falls, Ont., Canada.
†Sherman, Franklin, Dept. of Entomology, Clemson College, S. C.
Shirck, F. H., Box 237, Parma, Idaho.
Shotwell, R. L., 801-6th Ave., So. Bozeman, Mont.
Siegler, E. H., U. S. Bureau of Entomology, Washington, D. C.
†Simanton, F. L., Drawer 359, Monroe, Mich.
Simmons, Perez, 712 Elizabeth Street, Fresno, Calif.
Smith, Charles E., Exp. Station, Baton Rouge, La.
Smith F. F., Arlington Farm, Rosslyn, Va.
Smith, Herbert D., Le Mont Fenouillet, Hyeres, Var. France.
Smith, H. S., Citrus Experiment Station, Riverside, Calif.
Smith, L. B., Box H, Moorestown, N. J.
Smith, M. R., State Plant Board, A. and M. College, Miss.
†Smith, R. C., Service Technique, Port au Prince, Haiti.
Smith, R. H., Citrus Exp. Station, Riverside, Calif.
Smulyan, M. T., U. S. Bureau of Entomology, Melrose Hlds., Mass.
Snapp, O. I., Bureau of Entomology, Fort Valley, Ga.
Snow, S. J., 473 4th Ave., Salt Lake City, Utah.
Snyder, T. E., U. S. Bureau of Entomology, Washington, D. C.
Sorenson, Charles J., Experiment Station, Logan, Utah.
Spencer, Geo. J., Dept. Zoology, Univ. of B. C., Vancouver, B. C., Canada.
Spencer, Herbert, Experiment Station, Baton Rouge, La.
Spruijt, F. J., Box 786, Babylon, Long Island, N. Y.
Spuler, Anthony, Agricultural Exp. Station, Wenatchee, Wash.
Stafford, E. W., Agricultural College, Miss.
Stahl, G. F., Box 7, Chadbourne, N. C.
†Stear, J. R., 119 Deeds St., Legonier, Pa.
†Stearns, L. A., Univer. of Del., Newark, Delaware.
†Steiner, L. F., Cornelia, Ga.
Stene, A. E., Kingston, R. I.
St. George, R. A., Entomological Lab., E. Falls Church, Va.
Stirrett, G. M., Ent. Laboratory, Chatham, Ontario, Canada.
Stockwell, C. W., 1590 Pierce Ave., Camden, N. J.
Stone, W. E., Box 491, Orlando, Fla.
†Strand, A. L., Div. Entomology, Univ. Minn., St., Paul, Minn.
Strickland, E. H., University of Alberta, Edmonton,Canada.
†Strong, Lee A., Plant Quarantine & Control Adm., Washington, D. C.
†Sullivan, K. C., Board of Agriculture, Jefferson City, Mo.
Summers, J. N., 408 Atlantic Ave., Boston, Mass.
Swain, A. F., Box 428, El Monte, Calif.
Swaine, J. M., Entomological Branch, Ottawa, Canada.
†Swenk, M. H., 1410 No. 37th St., Lincoln, Neb.
Swezey, O. H., Hawaiian Sugar Planters' Exp. Station, Honolulu, H. T.

†Members who attended 1930 meeting.

Sweetman, H. L., M. A. C., Amherst, Mass.
Swingle, H. S., Box 247, Auburn, Ala.
Symons, T. B., Agricultural Exp. Station, College Park, Md.

Tanquary, M. C., University Farm, St. Paul, Minn.
Tenhet, J. N., Chadbourne, N. C.
Thomas, C. A., Kennett Sq., Pa.
Thomas, F. L., College Station, Texas.
Thomas, W. A., Chadbourne, N. C.
Thompson, B. G., 303 Agriculture Hall, Corvallis, Ore.
Timberlake, P. H., Citrus Exp. Station, Riverside, Calif.
Tissot, A. N., Experiment Station, Gainesville, Fla.
Titus, E. G., 1080 S. 5th Ave., Salt Lake City, Utah.
Todd, F. E., State Insectary, Capital Park, Sacramento, Calif.
Todd, J. N., 801 Smith-Young Tower, San Antonio, Texas.
Trimble, F. M., Camp Hill, Cumberland Co., Pa.
Troop, James, Agricultural Exp. Station, Lafayette, Ind.
Turner, Neely, Experiment Station, New Haven, Conn.
Turner, W. F., U. S. Peach Disease Lab., Fort Valley, Ga.
Underhill, G. W., Experiment Station, Blacksburg, Va.

Vance, A. M., Le Mont Fenouillet, Hyeres, Var. France.
Van Dine, D. L., Central Baragua, Baragua Camagney, Province, Cuba.
Van Duzee, E. P., Academy Sciences, San Francisco, Calif.
Van Dyke, E. C., University of California, Berkeley, Calif.
†Van Leeuwen, E. R., Box H, Moorestown, N. J.
Vansell, G. H., University Farm, Branch Coll. of Agriculture, Davis, Calif.
Van Zwaluwenberg, R. H., H. S. P. A., Experiment Station, Honolulu, H. T.
Vickery, R. A., 801 Smith-Young Tower, San Antonio, Texas.
Vorhies, Chas. T., University Station, Tucson, Ariz.

Wade, J. S., U. S. Bureau of Entomology, Washington, D. C.
Wadley, F. M., Bureau of Entomology., Washington, D. C.
Wakeland, C. C., Moscow, Idaho.
Walden, B. H., Agricultural Exp. Station, New Haven, Conn.
Walkden, H. H., 128 S. Minneapolis Ave., Wichita, Kansas.
†Walker, H. G., 403 E. 13th Ave., Columbus, Ohio.
†Wallace, F. N., 132 State House, Indianapolis, Ind.
Walter, E. V., U. S. Entomological Lab., San Antonio, Tex.
Walton, W. R., U. S. Bureau of Entomology, Washington, D. C.
Wardle, R. A., Univ. of Manitoba, Winnipeg, Canada.
Webb, J. L., U. S. Bureau of Entomology, Washington, D. C.
Webber, R. T., U. S. Bureau of Entomology, Melrose Hlds., Mass.
†Webster, R. L., State College, Pullman, Wash.
†Weed, Alfred, 114 E. 32nd St., New York, N. Y.
Wehrle, L. P., Univ. of Ariz., Tucson, Ariz.
†Weigel, C. A., Bur. Ent., Washington, D. C.
Weiss, H. B., 19 N. 7th Ave., Highland Park, New Brunswick, N. J.
Weldon, G. P., 420 East D. Street, Ontario, Calif.
Wellhouse, Walter, Iowa Agricultural College, Ames, Iowa.
Wheeler, W. M., Museum Comparative Zoology, Cambridge, Mass.

†Members who attended 1930 meeting.

Whelan, Don B., Dept. Ent., Univ. Nebraska, Lincoln, Nebr.
Whitcomb, W. D., 82 Plympton St., Waltham, Mass.
Whitehead, F. E., A & M. College, Stillwater, Oklahoma.
Wilcox, Joseph, Experiment Station, Corvallis, Oregon.
Wildermuth, V. L., Entomological Laboratory, Tempe, Ariz.
Willard, H. F., Box 340, Honolulu, H. T.
Williams, C. B., 29 Queens Crescent, Edinburgh, Scotland.
Wilson, C. C., 600 26th St., Sacramento, Calif.
Wilson, H. F., 1532 University Ave., Madison, Wis.
Winter, J. D., University Farm, St. Paul, Minn.
Woglum, R. S., Calif. Fruit Growers' Exchange, Los Angeles, Calif.
*Wolcott, G. N., Barneveld, New York.
Wood, W. B., Plant Quarantine & Control Admin., Washington, D. C.
Woods, W. C., Kent School, Kent, Conn.
Worthley, H. N., Old Exp. Sta. Bldg., State College, Pa.
†Worthley, L. H., 185 Summer St., Boston, Mass.
Wymore, Floyd H., University Farm, Davis, Calif.

Yeomans, M. S., 332 State Capitol, Atlanta, Ga.
†Yetter, W. P., Jr., 2 E. Locust St., Vincennes, Ind.
Yothers, M. A., Box 243, Yakima, Wash.
Yothers, W. W., Box 491, Orlando, Fla.
Young, M. T., Tallulah, La.
Yuasa, Hachiro, Institute of Ent., Kyoto Imperial Univ., Kyoto, Japan.

Zappe, Max P., Agr. Experiment Station, New Haven, Conn.
Zetek, James, Drawer Z, Balboa, Canal Zone, Panama.

Total Number of Active Members, 603.

ASSOCIATE MEMBERS

Aamodt, T. L., University Farm, St. Paul, Minn.
Allen, Norman, Exp. Station, Baton Rouge, La.
†Allen, Thos. C., 1339 Drake St., Madison, Wis.
Allen, W. L., Salisbury, Maryland.
Amis, Albert H., Apartado 36, Los Mochis, Sinaloa, Mexico.
†Anderson, Edwin J., Penn. State College, State College, Pa.
Anderson, W. E., Baton Rouge, La.
†Annand, P. N., Box 1100, Twin Falls, Idaho.
†Anthony, M. V., 144-13th Ave., Columbus, Ohio.
Arant, F. S., Auburn, Alabama.
†Arbuthnot, K. D., Drawer 359, Monroe, Mich.
†Arnold, R. B., c/o Tobacco By-Prod. & Chem. Corp., Richmond, Va.
Ashworth, John T., Danielson, Conn.
Audant, Andre, K. S. A. C., Manhattan, Kansas.
Avery, P. C., 801 Smith-Young Tower, San Antonio, Texas.

Badertcher, A. E., 50 College Ave., New Brunswick, N. J.
Bailey, I. L., Northboro, Mass.
Bailey, John W., Richmond University, Richmond, Va.
Bailey, S. F., University Farm, Davis, Calif.

*Life member.
†Members who attended 1930 meeting.

Ballou, C. H., Apartado 1368, San Jose, Costa Rica.
Bare, C. O., Box 1525, Sanford, Fla.
Bare, O. S., 1535 N. 32nd St., Lincoln, Neb.
Barnes, O. L., Entomological Lab., Tempe, Arizona.
Barnes, P. T., 908 Highland Ave., Palmyra, N. J.
Barrett, R. E., Box 171, Saticoy, Calif.
Bartlett, Irene L., Div. of Insects, National Museum, Washington, D. C.
†Bartlett, Kenneth A., 10 Court St., Arlington, Mass.
Baumgartner, M. H., Apto 62, Ciudad Obregon, Sonora, Mexico.
Beal, J. A., 501 Lewis Bldg., Portland, Oreg.
Becton, E. M., 707 Washington Ave., Palmyra, N. J.
Beddard, Wm. D., 1413 Granger Ave., Ann Arbor, Mich.
Benton, Curtis. U. S. Entomological Lab., West Lafayette, Ind.
Berry, P. A., Estacion Exp., Santiago de las Vegas, Cuba.
Berryhill, I. W., Box 523, McAllen, Texas.
Beutenmuller, William, 85 Elm St., Tenafly, N. J.
Bieberdorf, G. A., A. & M. College, Stillwater, Okla.
Billings, Samuel C., R. D. 1, Silver Spring, Md.
Birkett, T. E., 106 Whitten Hall, Columbia, Mo.
Bissell, Theo. L., Experiment, Ga.
Blaisdell, H. L., 964 Main St., Melrose Highlands, Mass.
†Blauvelt, W. E., 214 Thurston Ave., Ithaca, N. Y.
Bogue, Robt., 1543 Gordon St., Hollywood, Calif.
†Boillot, B. F., 110 Capitol Bldg., Jefferson City, Mo.
Bond, G. L., Box 297, Laurel, Miss.
Borodin, D. N., Yonkers, N. Y.
Botsford, R. C., Agricultural Exp. Station, New Haven, Conn.
†Bottger, G. T., Drawer 350, Monroe, Mich.
Bowen, M. F., 441 N. 5 E, Logan, Utah.
Box, Harold E., Agr. Exp. Sta., Tucuman, Argentina, S. A.
Breakey, Edward P., Biological Survey, O. S. U., Columbus, Ohio.
†Brewer, Erle G., 615 Front St., Toledo, Ohio.
Brigham, Wm. T., 77 Elizabeth St., New Haven, Conn.
Brindley, T. A., Science Bldg., Ames, Iowa.
Brinley, F. J., Zoological Lab., Agr. College, Fargo, N. D.
†Bronson, T. E., 229 Clifford St., Madison, Wisc.
Broome, G. C., Jr., 1532 University Ave., Madison, Wisc.
Brower, A. E., Agricultural College, Ithaca, N. Y.
Brown, J. G., c/o Sunmaid Raisins Growers, Fresno, Calif.
Brown, R. C., Bureau of Entomology, Melrose Highlands, Mass.
Browne, Ashley C., State Office Bldg., Dept. Agriculture, Sacramento, Calif.
Bruce, W. G., Dept. Ent., K. S. A. C., Manhattan, Kansas.
Brubaker, Ross W., 151 W. 11th Ave., Columbus, Ohio.
Brunson, M. H., Box H, Moorestown, N. J.
Brunson, M., Box 415, Picayune, Miss.
†Buchanan, Dwight, University Farm, St. Paul, Minn.
Buck, J. E., Rural Retreat, Va.
Burgess, E. D., 47 Sargent St., Melrose, Mass.
Butcher, F. G., Dept. of Entomology, Cornell University, Ithaca, N. Y.
Bynum, E. K., Box 366, Houma, La.

†Members who attended 1930 meeting.

Caldwell, E. G., Foley, Ala.
Calhoun, S. L., Box 564, Marfa, Texas.
Call, A. B., Box 254, Provo, Utah.
Campbell, C. F., Room 1, Masonic Bldg., Meadville, Pa.
Campbell, L. W., 79 New Montgomery St., San Francisco, Calif.
Cannon, E. W., c/o Calif. Spray Chemical Corp., San Jose, Calif.
Carpenter, H. H., State Plant Board, Houston, Miss.
Carpenter, S. J., Univ. of Tenn., Knoxville, Tenn.
Carroll, Mitchell, F. & M. College, Lancaster, Pa.
Carruth, L. A., State Coll., Brookings, S. D.
Carter, R. H., Bur. Chem. & Soils, Washington, D. C.
†Cartwright, O. L., Box 796, Florence, S. C.
Cavitt, H. S., 801 Smith Young Tower, San Antonio, Texas.
Chamberlin, J. C., Box 1100, Twin Falls, Idaho.
Chamberlain, W. J., Route 3, Corvallis, Oregon.
Chance, O. M., Box 424, W. Jackson, Miss.
Chapman, J. W., Silliman Inst., Dumaguete, P. I.
Chapman, W. W., 134 So. 2nd St., Philadelphia, Pa.
Childs, E. R., 901 Kilson Drive, Santa Ana, Calif.
Chistenson, L. D., Central Baragua, Prov. Camaguey, Cuba.
Clapp, S. C., Mountain Branch Station, Swannanoa, N. C.
Clarke, C. A., American Consulate, Kobe, Japan.
Clark, S. W., Sub-Sta. 15, Weslaco, Texas.
Clark, W. H., Exp. Station, Thomaston, Ga.
†Clifton, H. K., Research Dept., Belle Glade, Fla.
Cody, L. R., Hall of Justice, San Jose, Calif.
Coffin, O. T., 604 N. Electric Ave., Alhambra, Calif.
Cole, A. C., Jr., O. S. U., Columbus, Ohio.
Coleman, Wallace, R. D. 1, Silver Spring, Md.
Colmer, R. P., Moss Point, Miss.
Conklin, J. G., O. S. U., Columbus, Ohio.
Conn, Syrus, Tallulah, La.
Cooper, J. F., 1411 N. 12th St., Vincennes, Ind.
Couch, O. E., Box 83, Gila Bend, Arizona.
Cox, J. A., Experiment Station, Geneva, N. Y.
Craig, F. W., 1605 Quarrior St., Charleston, W. Va.
Crane, H. A., Box 935, Marysville, Calif.
†Crawford, A. W., Experiment Station, Geneva, N. Y.
Cressman, A. W., Box 5171, Sta. B., New Orleans, La.
Crooks, C. A., Box 976, Sandusky, Ohio.
Crowell, M. F., 24 Emery St., Medford Hillside, Mass.
Crowley, D. J., Long Beach, Washington.
Culbertson, R. E., Exp. Sta., Lexington, Ky.
Curl, L. F., Marfa, Texas.
Cushing, Emory C., Golovin, Alaska.

Daines, R. H., Jr., 357 E. 5 N. Logan, Utah.
†Darley, M. M., Dept. of Entomology, O. S. U., Columbus, Ohio.
†Davidson, R. H., 1510 Neil Ave., Columbus, Ohio.
Davis, E. G., U. S. Ent. Lab., Tempe, Arizona.
Davis, Louis G., 630 S. Whitcomb St., Fort Collins, Colo.

†Members who attended 1930 meeting.

Dean, F. P., Bur. Ent., Yakima, Wash.
†Dean, Ralph W., Dept. Entomology, O. S. U., Columbus, Ohio.
Dearborn, F. E., 216-13th St., S. W., Washington, D. C.
De Coursey, J. Don., 208 W. Nevada Ave., Urbana, Ill.
Deen, O. T., Box 205, Biloxi, Miss.
Deen, R. B., Tupelo, Miss.
Denberry, E. P., Greenfield, Tenn.
Denny, Charles, 119 Capitol Bldg., Jefferson City, Mo.
Diamond, V. R., 895 Richmond St., London, Ontario, Canada.
Dibble, C. B., Ent. Dept., State College, East Lansing, Mich.
†Dicke, F. F., Box 592, Charlottesville, Va.
†Dietrich, Henry, Lucedale, Miss.
Dills, L. E., 611 E. Seneca St., Ithaca, N. Y.
Dimick, Roland E., Agr. Bldg., Corvallis, Ore.
Dirks, C. O., Div. of Entomology, U. of M., Orono, Me.
Ditman, L. P., U. of Maryland, College Park, Md.
Dixon, J. W., Independence, Calif.
Dorst, H. E., 925 Indiana, Lawrence, Kansas.
Dorward, Kelvin, 106 Morrill Hall, Knoxville, Tenn.
Douglass, N. L., Box 613, Grenada, Miss.
Douglas, W. A., Box 164, Crowley, La.
Douglass, Wm. J., Box 94, Naco, Ariz.
Dove, W. E., Box 324, Charleston, S. C.
Dove, W. H., Cia Carbonifera de Sabinas, S. A. Rosita, Coahuila, Mexico.
Dowdle, Verda, U. S. A. C., Logan, Utah.
Drinnan, D. E., Route 1, Cumberland Gap, Tenn.
†Drumheller, C. E., Buena Vista, Ohio.
Duggan, C. E., Box 445, San Dimas, Calif.
Dutton, W. C., M. S. C. Dept. of Horticulture, East Lansing, Mich.
Dye, H. W., c/o Niagara Sprayer & Chemical Co., Middleport, N. Y.

Eaton, N. A., 640 Ditmas Ave., Brooklyn, N. Y.
Eberling, Walter, 301 E. Cyprus St., Anaheim, Calif.
Eddy, M. W., 249 W. Louther St., Carlisle, Pa.
Elmore, L. C., Y. M. C. A., Winston-Salem, N. C.
Esselbaugh, Chas. O., 57 Brighton Rd., Columbus, Ohio.
Evans, John H., Dept. Ent., Univ. of Illinois, Urbana, Ill.
†Everly, Ray T., 425 Fourth St., Toledo, Ohio.

Fagan, J. F., Bentonville, Arkansas.
Fall, F. L., 276 Montauk Ave., New London, Conn.
Farleman, M. G., East Lansing, Michigan.
†Farlinger, D. F., Cornelia, Ga.
Farmer, Lowell J., Moscow, Idaho.
Farrar, C. L., Fernald Hall, M. A. C., Amherst, Mass.
Farrar, Edward R., South Lincoln, Mass.
Farrar, M. D., State Ent. Bldg., Urbana, Ill.
Fattig, P. W., Box 788, Emory University, Ga.
Fey, K. Y., East Hill, Sia-Shih, Checkiang, China.
Filmer, R. S., Rutgers Univ., New Brunswick, N. J.
†Fletcher, F. W., 151 W. 11 Ave., Columbus, Ohio.

†Members who attended 1930 meeting.

Fox, D. E., 120 6th Ave. No., Twin Falls, Idaho.
Fox, Robert H., 1808 White Ave., Apt., 2, Knoxville, Tenn.
Franke, L. J., El Campo, Texas.
Frankenfield, J. C., U. S. Ent. Lab., Tempe, Arizona.
Frazier, J. M., Sta. A, Box 156, Hattiesburg, Miss.
Freeman, W. H., 314-79th St., Brooklyn, N. Y.
French, G. T., State Office Bldg., Richmond, Va.
Frost, L. A., Thayer International Bridge, Mercedes, Texas.
Fulton, R. A., Box 1100, Twin Falls, Idaho.

Garrettson, Geo. W., 702 Meridian Ave., So. Pasadena, Calif.
Garthside, Stanley, Farnham, Bucks, England.
Gates, L. M., 5342 Madison Ave., Lincoln, Nebr.
Gay, G., 7 Customs House Bldg., Charleston, S. C.
Gay, J. C., Jr., Box 813, Lamesa, Texas.
Geissler, Geo. H., Box 167, Vincennes, Ind.
Gersdorff, W. A., McLean, Va.
Getzendaner, C. W., Box 233, Puyallup, Washington.
Gibson, L. E., 964 Main St., Melrose Hlds., Mass.
Gilbertson, C. J., Sta. Coll., Brookings, S. D.
Gillespie, D. G., Exp. Sta., Hood River, Ore.
Gillette, Claude C., Mansfield Center, Conn.
Girardeau, J. H., McRae, Ga.
Gjullin, C. M., 231 New Post Office, Portland, Ore.
Glance, Grace E., Bur. of Entomology, Washington, D. C.
†Glover, L. C., Theta U. House, Durham, N. H.
Gnadinger, C. B., 4941 Upton Ave., So. Minneapolis, Minn.
Good, Newell E., 1811 Irving St., N. W., Washington, D. C.
Goodgame, L. J., Box 222, Aberdeen, Miss.
†Gould, George, Experiment Station, Norfolk, Va.
Grady, A. G., Sinclair Refining Co., E. Chicago, Ind.
Grady, H. J., 204 Franklin St., New York, N. Y.
Graham, C., College Park, Md.
Gram, Ernest, Statens Plantspatologiske, Lyngby, Denmark.
Grant, D. H., R. F. D. No. 1, Scotch Plains, N. J.
Gray, John, Box H, Moorestown, N. J.
Gray, Kenneth, 210 N. 16 St., Corvallis, Ore.
Gray, W. L., Box 433, Natchez, Miss.
Green, C. E., Limoneira Ranch, Santa Paula, Calif.
Green, E. C., 1101 W. Green St., Urbana, Ill.
Gregory, F. W., Federal Bldg., Niagara Falls, Canada.
Griffin, E. L., Food, Drug and Insecticide Admin., Washington, D. C.
Griffith, C. H., University Farm, St. Paul, Minn.
Grimes, D. W., Box 125, Durant, Miss.
Grimes, M. L., Route No. 1, Meridian, Miss.
Gross, Cecil R., Bureau Chemistry and Soils, Washington, D. C.
Grout, Roy A., 224 Hayward, Ames, Iowa.
Gunderson, A. J., c/o Sherwin-Williams Co., Cleveland, Ohio.

†Members who attended 1930 meeting.

Guthrie, H. E., 2644 Lincolnway, Ames, Iowa.
Gwin, C. M., 308 N. Blount St., Madison, Wisc.
Gwinner, Charles C., 6300 State Road, Philadelphia, Pa.

Haas, Louise E., Iowa State College, Ames, Iowa.
Haasis, F. A., Dept. Plant Pathology, Cornell Univ., Ithaca, N. Y.
Haden, Wm. Rau, 86 Chittenden Ave., Columbus, Ohio.
†Haines, K. A., O. S. U., Columbus, Ohio.
Hall, R. C., University of Michigan, Ann Arbor, Mich.
Hambleton, E. J., Escola de Agricultura, Vicosa Minas Geraes, Brazil.
†Hamilton, D. W., Lyndon, Ill.
Hanson, A. J., West Washington Exp. Station, Puyallup, Washington.
Harris, F. H., 473-4th Ave., Salt Lake City, Utah.
Harris, J. A., N. C. Department of Agriculture, Raleigh, N. C.
Harrison, P. K., Box 56, Fairfax, S. C.
Hartnack, Hugo, 20 E. Jackson Boulevard, Chicago, Ill.
Hassan, A. S. Giza, Egypt.
†Haug, G. W., A. and M. College, Miss.
Hawkins, J. H., Agr. Exp. Station, Orono, Me.
Heming, W. E., Ont. Agr. Coll., Guelph, Ont., Canada.
Henderson, J. R., c/o McCormick & Co., Baltimore, Md.
Henderson, W. W., Agr. Experiment Station, Logan, Utah.
†Henerey, W. T., Clemson College, S. C.
Henneberry, T. V., Box 976, Sandusky, Ohio.
Hensill, Geo. S., Univ. of California, Berkeley, Calif.
Hering, P. E., Renssalaer Polytechnic Inst., Troy, N. Y.
†Herr, E. A., Corn Borer Lab., Oak Harbor, Ohio.
Hertzog, P. H., Hightstown, N. J.
†Hill, Sam O., 10 Court St., Arlington, Mass.
Hills, O. A., Box 173, Hermiston, Oregon.
Hines, Chesley, Yazoo City, Miss.
Hinman, F. G., Rapelze, Montana.
Hinnenkamp, Freda B., Box 1100, Twin Falls, Idaho.
Hobbs, Edward, 801 Smith Young Tower, San Antonio, Texas.
†Hockenyos, G. L., 1003 Oregon St., Urbana, Ill.
Hodgson, B. E., 10 Court St., Arlington, Mass.
Hoffman, Clarence H., 1133 Rhode Island St., Lawrence, Kansas.
Hoidale, P. A., Orlando, Fla.
Holbrook, J. E. R., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Holdaway, F. G., Div. Entomology, Canberra, F. C. T. Australia.
Hollingsworth, H. S., 128 S. Minneapolis Ave., Wichita, Kansas.
Hollingsworth, W. B., Picayune, Miss.
†Hollister, W. O., c/o Davey Tree Experts, Kent, Ohio.
Hookum, Don W., Univ. Maryland, College Park, Md.
†Hopkins, F. G., 406 Morrill Hall, Knoxville, Tenn.
Horton, George, Box 5215, State College Station, Raleigh, N. C.
Horton, Harvey A., Carnegie, Oklahoma.
Hudson, G. H., Plattsburg, N. Y.

†Members who attended 1930 meeting.

Hull, F. M., 1104 University St., Oxford, Miss.
Hunt, R. W., Box 62, Whittier, Calif.
Hutchinson, R. N., 525 Park St., Covina, Calif.

†Irish, C. F., 418 E. 105th St., Cleveland, Ohio.

Johnson, A. C., 612 Mills Bldg., El Paso, Texas.
Johnson, J. Peter, Exp. Sta., New Haven, Conn.
†Johnson, Paul, Dept. Entomology, Columbia, Mo.
Johnson, P. C., School of Forestry, State College, Corvallis, Ore.
†Johnston, H. G., State College, Ames, Iowa.
Johnston, Harmon R., Box 5215 State College Station, Raleigh, N. C.
Jones, E. T., 126 S. Minneapolis Ave., Wichita, Kansas.
Jones, E. W., Box 616, Walla Walla, Washington.
†Jones, G. D., 106 Whitten Hall, Columbia, Mo.
Jones, Howard A., Bur. Chemistry & Soils, Washington, D. C.
†Jones, L. G., Box 359, Monroe, Mich.
†Jones, L. J., Ellington, Mo.
†Jones, R. M., Fruit Exp. Station, Mountain Grove, Mo.
Jones, Sloan E., College Station, Texas.
†Jones, Sidney C., State College, Corvallis, Ore.
Jones, Victor E., University of Idaho, Pocatello, Idaho.
Jones, W. W., 1300–10th St., Douglas, Ariz.
Jung, Goey Park, Bur. Ent., Nanking, China.

Kamal, Mohamed, Cotton Research Branch, Giza, Egypt.
Keck, Chester B., Box 491, Orlando, Fla.
Kegley, Fred W., 406 Morrill Hall, Knoxville, Tenn.
Keler, Stefan, Pantswowy Institute, Nankowo-Rolniczy, Bydgoszaz, Poland.
Kelley, R. W., Box 1959, Orlando, Fla.
Kellogg, C. R., c/o Fukien University, Foochow, China.
Kellogg, E. W., Box 552, Santa Barbara, Calif.
Kelly, Sam G., 1600 Houston St., Manhattan, Kansas.
Kennedy, R. D., 7 Graceland Ave., Staten Island, N. Y.
Kent, Virgil F., 308 W. Elm St., Monroe, Mich.
Kidder, Nathaniel T., Milton, Mass.
Kile, H. J., 406 Morrill Hall, Knoxville, Tenn.
Kinsley, C. H., 1809 C St., Sacramento, Calif.
Kirkpatrick, A. F., 178 N. Alta Vista Ave., Monrovia, Calif.
Kislanko, J. P., Wiggins, Miss.
Knight, Hugh, Box 382, Upland, Calif.
Knight, Paul, College Park, Maryland.
Knipling, Edw. F., 2121 Lincolnway, Ames, Iowa.
Koch, K. L., Univ. of Wis., Madison, Wis.
Kohle, G. M., Hamilton, Montana.
Kraus, E. J., Univ. of Chicago, Chicago, Ill.

Lacroix, D. S., 24 Prospect St., Amherst, Mass.
LaFollette, J. R., 329 Alta Ave., Whittier, Calif.
Lamiman, J. F., University of Calif., Berkeley, Calif.

†Members who attended 1930 meeting.

Lanchester, Horace P., Parma, Idaho.
†Landis, Birely J., 151 W. 11th Ave., Columbus, Ohio.
Landon, W. E., R. F. D., San Dimas, Calif.
Latta, Randall, Box 566, Sumner, Washington.
Lebert, Carol D., Box 83, Gila Bend, Ariz.
Ledyard, E. M., U. S. Smelting Co., Salt Lake City, Utah.
Lewis, C. W., 10 Court St., Arlington, Mass.
Light, S. F., Palm Springs, Calif.
Lindgren, David L., University Farm, St. Paul, Minn.
Ling, Setek, 188 Juan Luna, Manila, P. I.
Liston, B. E., 925 Indiana St., Lawrence, Kansas.
Liu, Chung Lo, Tsing Hua College, Peking, China.
Livingston, B. P., Dept. Agr., Montgomery, Ala.
Livingstone, E. M., 515 Jefferson St., Danville, Va.
Lobdell, Mrs. R. N., Everglades Exp. Station, Belle Glade, Fla.
Longan, E. W., State Office Bldg., Sacramento, Calif.
Lopez, A. W., Box 27, La Carlota, P. I.
Lyon, S. C., Box 491, Davidson, N. Carolina.

†Mabee, W. B., Exp. Station Bldg., State College, Pa.
†MacAndrews, A. H., Coll. of Forestry, Syracuse, N. Y.
Maier, E. A., Mathews, La.
Mail, G. A., Montana Exp. Sta., Bozeman, Montana.
Maloney, G. A., Box 264, Tallulah, La.
Manson, Geo. F., Entomological Lab., Lethbridge, Alberta, Canada.
Marsh, H. L., Box 218, Whittier, Calif.
Marshall, G. E., 630 R. St., Bedford, Ind.
Marshall, James, Annapolis Royal, Nova Scotia, Canada.
†Marston, L. Chester, Jr., Univ. of Toronto, Toronto, Canada.
Martin, C. H., 634 S. Washington St., Whittier, Calif.
Martin, J. F., Bureau Plant Industry, Washington, D. C.
†Marvin, G. E., 1532 University Ave., Madison, Wis.
†Mason, H. C., 151 W. 11th Ave., Columbus, Ohio.
†Mayer, C. C. B., O. S. U., Columbus, Ohio.
McAllister, L. C., Jr., Cherryfield, Me.
McCampbell, S. C., Zool. Bldg., C. A. C., Fort Collins, Colo.
McCreary, Donald, Dept. Entomology, Newark, Delaware.
McDonnell, C. C., Food, Drug & Insecticide Admin., Washington, D. C.
McEvilly, J. E., Chamber of Commerce, McComb, Miss.
McEvoy, J. A., 136 Church St., Putnam, Conn.
McGarr, R. L., Box 374, Tallulah, La.
McGough, James M., Exp. Station, Santiago de las Vegas, Cuba.
†McGovran, E. R., I. S. C., Ames, Iowa.
†McKay, R. S., Owensville, Ohio.
McNally, A. Gordon, 390 Colborne St., London, Ontario, Canada.
McNeel, T. E., Mound, La.
Meachem, F. B., State College, Raleigh, N. C.
Mechling, E. A., Line Street and Coopers Creek, Camden, N. J.

†Members who attended 1930 meeting.

†Melvin, Roy, 136 Campus Ave., Ames, Iowa.
Menagh, C. S., U. S. Bureau of Entomology, Washington, D. C.
†Mendenhall, E. W., 97 Brighton Rd., Columbus, Ohio.
Merino, Gonzala, c/o Bureau of Agriculture, Manila, P. I.
Merrill, D. E. 501 W. Sycamore St., Rogers, Ark.
†Merritt, James M., Haslett, Mich.
Millar, J. A., 36 Charles St., Wakefield, Mass.
Millar, P. H., State Plant Board, Little Rock, Ark.
Mills, A. S., Box 991, San Juan, P. R.
Mills, H. B., Dept. Entomology, College Station, Texas.
Mills, James, Jr., Hamilton, Glen Co., Calif.
Milton, Jack, Box 148, Corinth, Miss.
Mohr, Carl, Univ. of Ill., Urbana, Ill.
Montgomery, B. Elwood, Purdue Univ., Lafayette, Ind.
Moody, D. C., Cornelia, Ga.
Moody, D. L., Box 133, Presidio, Texas.
Moore, Warren, Agr. Experiment Station, New Brunswick, N. J.
†Morofsky, Walter F., Dept. Entomology, East Lansing, Mich.
Morrill, A. W., Jr., 712 Elizabeth St., Fresno, Calif.
Morris, E. L., 812 E. First St., Santa Ana, Calif.
Mortenson, E., Pearsall, Texas.
Murillo, Luis M., Dept. Agr., Bogota, Colombia, S. A.
Myers, John H., 501 E. Daniel St., Champaign, Ill.
†Myers, L. E., A. & M. College, Miss.

Neil, F. A., Room 50, 12 So. Market St., Boston, Mass.
Nel, R. I., Naga Hoeta Estate, Sumatra E. C., Permatang, Siantar.
†Nelson, F. C., 118 Chandler Ave., Roselle, N. J.
Nelson, R. H., Dept. Entomology, State College, Ames, Iowa.
†Nettles, Wm. C., Clemson College, S. C.
Newbegin, I. B., Wakefield, Mass.
Newton, J. H., Paonia, Colo.
Noble, L. W., Tallulah, La.
Norris, R. K., Pinnacle Packing Co., Medford, Oregon.

O'Dell, J. H., Box 1857, Phoenix, Ariz.
Ohlendorf, Walter, Tlahualilo, Durango, Mexico
Osterberger, B. A., Agr. Exp. Station, Baton Rouge, La.

Page, G. N., Girvin, Texas.
Parish, H. E., Menard, Texas.
Parker, Lawrence B., Box H, Moorestown, N. J.
Peets, N. D., Box 144, Brookhaven, Miss.
Pegler, Harold C., Box 2833, Los Angeles, Calif.
†Pepper, Bailey B., Dept. Entomology, O. S. U., Columbus, Ohio.
Perry, Robert A., 3720 W. 59th Place, Los Angeles, Calif.
Phillips, A. M., Box 2080, Orlando, Fla.
Phillips, G. L., Baldwyn, Miss.
Phillips, Saul, Conservation Commission, Albany, N. Y.

†Members who attended 1930 meeting.

Plass, Norman H., 1620 Highland Ave., Knoxville, Tenn.
Plummer, C. C., O. S. U., Columbus, Ohio.
Pope, J. B., Piura, Peru, S. A.
Powers, E. B., 133 E. Hillvail St., Knoxville, Tenn.
Prevost, E. S., Clemson College, S. C.
Primm, James K., 204 Franklin St., New York, N. Y.
Proper, A. B., Bureau of Entomology, Melrose Highlands, Mass.

Rasek, J. M., Brno cerná-Pole 201 Chechoslavakia
Rawlings, R. T., Box 17, Westervelt, Ill.
Reed, L. B., Box 146, Chadbourne, N. C.
†Reed, Thomas W., Experiment Station, Geneva, N. Y.
Reeves, J. A. Box 22, Fern Park, Fla.
Remy, Theron P., 2314 Chrysler Bldg., New York, N. Y.
Reynolds, G. D., Route 1, Silver Spring, Md.
Rice, Paul L., Moscow, Idaho.
†Richardson, H. H., I. S. C., Ames, Iowa.
Riddle, (Miss) Hazel W., Fargo, N. D.
Ries, Donald T., 209 E. Foster St., State Coll., Pa.
Rippey, H. K., Box 243, Indianapolis, Ind.
Roark, C. B., Estacion Experimental, Canete, Peru.
Roberts, J. H., Dept. Entomology, College Park, Md.
Roberts, Raymond, 1329 N. 41st St., Lincoln, Nebr.
Roberts, R. A., Box 509, Uvalde, Texas.
Rolfs, Archie R., Box 243, Yakima, Wash.
Rolfs, P. H., Viscosa E. F., Leopoldina, Minas Geraes, Brazil.
Roney, J. N., Dickinson, Texas.
Root, E. R., Medina, Ohio.
Roseling, C. F., Weslaco, Texas.
Rothe, C. H., Box 1117, Phoenix, Ariz.
Roullard, Fred P., 220 Holland Bldg., Fresno, Calif.
Russell, E. E., Ent. Lab., Tempe, Ariz.
Russo, Giuseppe, Estacion Nacional Agronomica, Moca (Rep. Dominicana), Porto Rico.
Ryberg, M. E., c/o Boyce Thompson Instit. Plant Research, Yonkers, N. Y.

Salman, K. A., 325 Giannini Hall, Univ. of Calif., Berkeley, Calif.
Salt, R. W., Entomological Lab., Lethbridge, Alberta, Canada.
†Sanchez, Ernesto e Estrada, Calle 20, No. 21, Entre 15, Vedado, Habana, Cuba.
Sankowsky, N. A., Box 243, Elizabeth, N. J.
Savage, J. R., Agr. Exp. Sta., Wooster, Ohio.
Sazama, F. B., 1532 University Ave., Madison, Wis.
Schaeffer, Mlle Cor, 92 Rue Victor Hugo, Bois- Colombes, Seine, France.
Schaffner, J. V., Jr., Bureau of Entomology, Melrose Highlands, Mass.
Schenk, Gilbert, 7437 Summit St., Kansas City, Mo.
Schlupp, W. F., Newcomerstown, Ohio.
Schmidt, C. T., Univ. Farm, St. Paul, Minn.
Schread, J. C., 247 Vine St., Bridgeport, Conn.

†Members who attended 1930 meeting.

Schwardt, H. H., University of Arkansas, Fayettesville, Arkansas.
Sellers, W. F., 217 Main St., Melrose, Mass.
Shands, W. A., 1630 N. 7th St., Grand Junction, Colo.
†Sheaffer, F. E., 636 W. 38th St., Indianapolis, Ind.
Sheffield, S. S., Box 2080, Orlando, Fla.
Sheldon, H. B., Santa Paula, Calif.
†Shepard, H. H., Bur. Ent., Washington D. C.
†Sherman, Franklin, Agr. College, East Lansing, Mich.
†Shropshire, L. H., Box 463, Sta. A., Ames, Iowa.
Shull, W. E., University of Idaho, Moscow, Idaho.
Singleton, J. M., Hidalgo, Texas.
Slack, Torbert, Box 773, Lake Charles, La.
Sleesman, G. B., Box 23, North Glenside, Pa.
Sleesman, J. P., Ohio Agr. Exp. Sta., Wooster, Ohio.
Smith, C. M., 424 Allison St. N. W., Washington, D. C.
Smith, F. A., Senatobia, Miss.
Smith, G. A., State Forester's Office, State House, Boston, Mass.
Smith, G. E., Albion, N. Y.
Smith, G. L., Delta Laboratory, Tallulah, La.
Smith, L. M., University of California, San Jose, Calif.
Smith, R. G., 55 Payson Avenue, New York, N. Y.
Smith, S. D., Box 62, San Antonio, Texas.
Smith, W. F., 152 S. Lake Ave., Pasadena, Calif.
*Smyth, E. Graywood, Hacienda Cartavio, Salaverry, Peru.
Soliman, L. B., Cotton Plant Board, Giza, Egypt.
Spangenberg, Herbert, 137 N. San Joaquin St., Stockton, Calif.
Speer, G. T., Apto 62, Cuidad Obregon, Sonora, Mexico.
Stabe, H. A., Box 376 Univ. Sta., Baton Rouge, La.
†Stanley, W. W., Tenn. Agr. Exp. Sta., Knoxville, Tenn.
Steenburg, W. E., 228 Dundee St., E., Belleville, Ontario, Canada.
Steinweden, J. B., 149 Calif. St., San Francisco, Calif.
Stevenson, W. A., Box 1896, Tucson, Ariz.
Stewart, M. A., Rice Inst., Houston, Texas.
Stickney, F. S., 724 Earlham Drive, Whittier, Calif.
Stiles, C. F., Box 37, Stillwater, Okla.
Stirland, La Grande, Providence, Utah.
Stone, M. W., Box 297, Alhambra, Calif.
Stracener, C. L., La. Exp. Sta., Baton Rouge, La.
Strand, Thomas P., Box 478, Pullman, Wash.
Struble, G. R., 341 Giannini Hall, Univ. of Calif., Berkeley, Calif.
Summerland, S. A., Bentonville, Ark.
Swingle, M. C., Box H, Moorestown, N. J.
Symonds, C. M., Bureau of Entomology, Melrose Hlds., Mass.

Talbert, T. J., Whitten Hall, Columbia, Mo.
Taylor, R. L., College of Forestry, Syracuse University, Syracuse, N. Y.
Thomason, H. L., 514 E. 8th St., Los Angeles, Calif.

†Members who attended 1930 meeting.
*Life member.

Thompson, Friar M., Jr., Rutgers College, New Brunswick, N. J.
Thompson, Robert W., Dept. Entomology, Guelph, Canada.
Thompson, W. L., Lake Alfred, Fla.
Thomson, J. R., Box 445, Ft. Valley, Ga.
†Tinkham, E. R., Box 242, Presidio, Texas.
Tischler, Nathaniel, 215 Chamberlain Pl., Ames, Iowa.
Tolles, G. S., Phylean House, East Lansing, Mich.
Townsend, J. F., 50 Livingston St., New Haven, Conn.
Townsend, L. H., Univ. of Ill., Urbana, Ill.
Toyne, Arthur, 404 Cypress Ave., Pasadena, Calif.
Travis, Bernard, State College, Ames, Iowa.
Tubbs, D. W., Tustin, Calif.
Tuckett, J. E., Indio, Calif.

Ulman, P. T., European Corn Borer Control, Auburn, Ind.

Van Aller, T. S., 902 Charleston St., Mobile, Ala.
Van der Meulen, P. A., Rutgers Univ., New Brunswick, N. J.
Vickery, R. K., Watsonville, Calif.
†Vogel, M. A., Experiment Station, Wooster, Ohio.

Wagner, G. B., Dept. Ent., K. S. A. C., Manhattan, Kans.
Wall, R. E., Experiment Station, Bozeman, Mont.
Wallis, R. L., Bureau of Entomology, Melrose Hlds., Mass.
Waters, Harold A., 143–8th Ave., East, Twin Falls, Idaho,
Watson, L. R., Alfred, N. Y.
†Watts, H. R., Box 1022, Louisville, Ky.
Webb, R. J., Drawer 359, Monroe, Mich.
Weed, C. M., State Normal School, Lowell, Mass.
Wells, A. B., Bryn Athyn, Pa.
Wells, R. W., 1162 E. Main St., Galesburg, Ill.
West, L. S., Battle Creek College, Battle Creek, Mich.
Wheeler, A. J., Madison, Tenn.
Whitten, Russell R., 104 Ashland St., Melrose Hlds., Mass.
Wilbur, D. A., K. S. A. C., Manhattan, Kansas.
Willey, C. R., Room 1112, State Office Bldg., Richmond, Va.
Williams, L. L., Newark Delaware.
Williams, O. L., Bayard, Iowa.
Williams, V. E., 1324 Elm St., San Gabriel, Calif.
Williamson, Warren, R. D. 5, Galesburg, Ill.
Wilson, G. R., 1620 Santa Clara Ave., Alameda, Calif.
Winchester, H. I., R. D. 1, Wakefield, Mass.
Wisecup, C. B., Sanford, Fla.
Woke, P. A., Bureau of Entomology, Washington, D. C.
Wolfenbarger, D. O., Dept. Entomology, Cornell Univ., Ithaca, N. Y.
Woodruff, L. C., 1212 Louisiana St., Lawrence, Kan.
Woodside, A. M., Staunton, Va.
Woodworth, C. E., 114 N. Charter St., Madison, Wisc.

†Members who attended 1930 meeting.

Wooldridge, Reginald, Bureau of Entomology, Melrose Hlds., Mass.
Wray, D. L., Jr., Box 834, Shelby, N. C.
Wright, P. F., 211 Chestnut St., Lodi, Calif.

Yeates, J. M., Box 374, Tallulah, La.
York, C. H., 542 Jefferson St., Pomona, Calif.
York, G. T., Box 703, Riverside, Calif.
Young, H. C., Box 1910, Tucson, Ariz.

Young, H. D., Bureau Chemistry and Soils, Washington, D. C.
Zeimet, Carlo, Bureau of Entomology, Washington, D. C.
Ziegler, L. W., 1251 W. Masonic St., Apt. No. 1, Gainesville, Fla.
Zeisert, E. E., RR 6, Brookville, Ohio.
Zimmerman, Mrs. H. K., 317 Kensington Ave., Astoria, Oregon.
Total Number of Associate Members, 549.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Aulló, Costilla, Dr. Manuel, Laboratorio de la Fauna Forestal Espanola, Ferraz, 40 Madrid, Spain.

Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., University of Stellenbosch, Stellenbosch, C. P. South Africa.

Carpenter, Dr. George H., University of Manchester, Manchester, England.
Collinge, W. E., 55 Newhall St., Birmingham, England.

Danysz, J., Laboratorie de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Kolonial Instit., Mauritskade 65–66, Amsterdam, Holland

Escherich, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.

Filipjev, T. N., Gertzena 44, Leningrade, Russia.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.

Goding, F. W., Box 448, Livermore Falls, Maine, U. S. A.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.

Harukawa, Chukichi, Kurashiki, Okayama-Ken, Japan.
Herrera, A. L., Care Secretaria de Agricultura y Formento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr. G., Museum Nationale Hungaricum, Budapest, Hungary.

Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.

Kulagin, Nikolai M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.

Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., 795 Church St., East, Pretoria, South Africa.

Mally, C. W., University of Stellenbosch, Stellenbosch, C. P., South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokrzecki, Dr. Sigismond, Director, Instit. of Forest Protection and Entomology, Skierniewice, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.

Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.

Parker, Thedore, Leeds University, Leeds, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.

Read, Charles S., Mendoza, Argentine Republic, South America.
Rosenfeld, A. H., Am. Sugar Cane League, 1005 New Orleans Bank Bldg., New Orleans, La.
Ruzkowski, J. W., Solacka, Poznan, Poland.

Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Scaramuzza, L. C., Camaguey, Cuba.
Schoyen, Prof. W. M., Zoological Museum, Oslo, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Stellwaag, Dr. Frederich, Neustadt, a. d. Haardt, Germany.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand
Tragardh, Ivor, Experimental Faltat, Stockholm, Sweden.
Trouvelot, Bernard, Inst. Agr. Research, Paris, France.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.

Urich, F. W., Department of Agriculture, Port of Spain, Trinidad, West Indies.

Total Number of Foreign Members, 52
Life Members, 6
Grand Total of Members, 1204

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Proceedings of the Forty-Third Annual Meeting of the American Association of Economic Entomologists

The Forty-Third Annual Meeting of the American Association of Economic Entomologists was held in the Electricity Building, at the Case School of Applied Science, Cleveland, O., December 29, 1930 to January 1, 1931.

The Section of Apiculture convened at 2 p. m. December 29. The program included a number of interesting papers and a symposium on honey. R. L. Parker presided and E. J. Anderson acted as secretary protem.

On Tuesday the members of this Section visited the A. I. Root Company plant at Medina, O. and inspected the work on apiculture that is being conducted there.

S. W. Bilsing, College Station, Texas, was elected Chairman, and J. M. Robinson, Auburn, Ala., was elected Secretary for the ensuing year.

The Section of Plant Quarantine and Inspection convened at 10 a. m. December 30th. Chairman E. N. Cory presided and in the absence of the Secretary, E. R. Sasscer acted in his place. Fourteen papers, together with reports of the National Plant Board and Regional Plant Boards occupied the morning and afternoon sessions. A review of the work of Plant Quarantine and Control Administration was presented by Lee A. Strong and papers on some of the major clean-up and eradication projects in the United States, including such pests as the Mediterranean Fruit Fly, the European Corn Borer and the Gipsy Moth were reviewed and discussed. Other phases of quarantine and control work were presented during the sessions. The Section was favored by a paper well illustrated by lantern slides concerning the quarantine work in Cuba by Ernesto Sanchez Estrada, which was intensely interesting.

K. C. Sullivan, Jefferson City, Mo. was elected Chairman and S. B. Fracker, Washington, D. C. Secretary for the ensuing year.

The Section of Extension held its annual session on Thursday evening, January 1, in one of the down town hotels in Cleveland. A very in-

teresting program was presented, including a symposium on the effect of the 1930 drouth upon insect population. There was a large attendance.

The officers selected for the ensuing year were Chairman, Leonard Haseman, Columbia, Mo., Secretary, R. W. Harned, Agricultural College, Miss.

The Entomologists Dinner was held at Western Reserve University on the evening of December 31st. About 250 members and visitors attended. The head table was reserved for past presidents of this Association and of the Entomological Society of America, together with the guest of honor, Dr. W. J. Holland, Carnegie Museum, Pittsburgh, Pa.

President Sherman introduced Dr. W. E. Britton as toastmaster and Dr. Holland was the principal speaker. He was followed by Dr. Edith M. Patch, President of the Entomological Society of America, and a number of past presidents of both Societies. The occasion was a very enjoyable one to all those who attended.

The main Association meetings opened Wednesday morning, December 31st with the usual business session, which was followed by the address of President Franklin Sherman on "Census Taking in Entomology." The afternoon session and a full program for the following day was given over to the presentation of papers covering a wide range of entomological work. The final business was concluded late in the afternoon of January 1. The membership of the Association was increased by 101, 95 by election and 6 by reinstatement. One Life Member was also admitted.

J. S. Houser, Wooster, O., was elected President for the ensuing year.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order at 10:00 a. m. December 31 by President Franklin Sherman. Over 250 members and visitors attended the session and the names of the members who signed the register are indicated by a dagger in the printed membership list.

PRESIDENT FRANKLIN SHERMAN: The Forty-Third Annual Meeting of the American Association of Economic Entomologists will please come to order.

The first item of business is the report of the Secretary.

REPORT OF THE SECRETARY

The membership at the Des Moines Meeting was 490 active, 468 associate and 50 foreign members, totaling 1008. The present membership is 577 active, 516 associate and 51 foreign, totaling 1144, making the net increase 136. This increase and change in the classes of members is due to the addition of members by election and rein-

statement at the time of the Des Moines meeting and loss in membership as result of non-payment of dues and deaths since that time. There are at the present time 8 active and 27 associate members who will be dropped January first unless their dues are paid.

The records available show that two active and five associate members died during the year.

On January 5, 1930 Dr. Herbert J. Pack, associate member, who was Professor of Entomology at the Utah Agricultural College, passed away. He was a native of Utah, graduated from the Utah Agricultural College and later received his doctor's degree from Cornell University. He was well known and highly respected throughout his native state.

Dr. W. A. Orton, associate member, died at Tacoma Park, Washington, January 7. He had served more than 25 years in the Bureau of Plant Industry of the United States Department of Agriculture, was one of the original members and for 12 years, Vice-Chairman of the Federal Horticultural Board. While his work was chiefly along the line of plant disease investigations, he had a very great interest in insect problems and during the last few years while connected with the Tropical Plant Research Foundation, was largely responsible for instituting a number of the entomological projects carried on by that organization.

March 13, 1930, marked the passing of Dr. S. A. Forbes who will always be remembered as one of the pioneer outstanding economic entomologists in this country and whose reputation was world wide. His achievements in Entomology and in the broader field of Natural History will cause his name to be honored and respected and the work which he accomplished is a fitting tribute to his memory. Dr. Forbes was the only member of this association who held the office of President for more than one year which evidences the high esteem in which he was held by his associates in the field of Entomology.

On May 1, 1930, Dr. William Barnes passed away. He was a native of Illinois and had distinguished himself as a surgeon, after graduating from Harvard in 1883 and the Harvard Medical School in 1886. He was intensely interested in Lepidoptera and established a private museum at Decatur, Ill., where one of the finest collections of American Lepidoptera in the world was assembled. He was a man of broad interests and a staunch exponent of the value of entomology. His collection, which is a memorial to his intense interest in this subject, has now been acquired by the United States National Museum where it will always be available for scientific workers.

On June 1, 1930, Mr. Jesse W. Barnes, an associate chemist in the Bureau of Chemistry and Soils of the United States Department of Agriculture, died after a short illness. He was engaged in work on insecticides and at the time of his death was studying an improved method of determining the presence of small quantities of arsenic.

On December 20, 1930, Mr. Geo. G. Ainslie died at Washington, D. C. He had been engaged in entomological work most of the time since 1908 and was engaged in the study of Cereal and Forage insects during most of that period for the Bureau of Entomology. He was a very capable research worker and was highly respected by all who knew him.

On December 22, 1930, Professor James S. Hine died very suddenly at Columbus, Ohio. For many years he was connected with the Department of Zoology and Entomology of the Ohio State University, specializing in Tabanidae and in Apiculture. He had a wide acquaintance among the entomologists of the United States and was held in high esteem by the members of this Association and of related societies.

On December 28, 1930, Mr. Norman E. Shaw, who for many years was a member of this Association but who was not a member this year, died as the result of an automobile accident in northern Ohio. For a number of years he was State Nursery Inspector of Ohio, later State Secretary of Agriculture, and more recently, Associate Editor of "The Ohio Farmer." He was a man of much ability and promise and was highly respected by a wide circle of residents of Ohio and other states.

The Fifth Annual Meeting of the Cotton States Branch was held at Jackson, Miss., February 6 and 7, 1930. Ninety-two members and visitors were present, including Prof. Franklin Sherman, President of the parent association. On February 8th a tour was made to the Delta Laboratory of the Bureau of Entomology at Tallulah, La., where all phases of cotton insect work conducted there was explained. The meeting was very successful and had the largest attendance of any meeting of this branch. The officers elected were: Chairman, J. M. Robinson, Auburn, Alabama; Vice-Chairman, S. W. Bilsing, College Station, Texas: Secretary, Oliver I. Snapp, Fort Valley, Georgia.

The Fifteenth Annual Meeting of the Pacific Slope Branch was held at the University of Oregon at Eugene, Oregon, June 19–20, 1930. Forty-one members and visitors were present. One session was devoted to a joint meeting with the biologists and an afternoon excursion was made to the state college and experiment station at Corvallis. The following officers were elected: Chairman, Roy E. Campbell, Alhambra, California; Vice-Chairman, H. E. Burke, Palo Alto, California; Secretary, H. H. Scullen, Corvallis Oregon.

The Eastern Branch held its Third Annual Meeting at the American Museum of Natural History in New York City, November 20–21, 1930. Two days were devoted to the reading of papers. There was a large attendance. The officers elected were: Chairman, W. J. Schoene, Blacksburg, Virginia; Vice-Chairman, Philip Garman, New Haven, Connecticut, Secretary, Harry B. Weiss, Trenton, New Jersey.

Indices to the Literature of American Entomology

Indices I and II:

The sales of these indices during the current year have decreased, only $126.50 being received on this account. There is still an ample supply available for sale.

Index III:

The sales of Index III are slightly less than during the previous year, amounting to $121. There is also an ample supply of this publication available.

Index IV:

Index IV has been printed and is ready for distribution. Advance sales have been made amounting to $338. The number of pages of this index exceeds any former issue and the price is one dollar less than has been charged for any index previously issued. The number of subscriptions received from members is far less than should be the case because of the low price and the great value of this book to every working entomologist. Members are urged to support this publication by subscribing for a copy as under present conditions it will be necessary to make a heavy draft from other association funds in order to pay for the printing and distribution of this book.

The report on the Journal of Economic Entomology will be submitted by the Business Manager.

There is attached hereto a statement of the cash receipts and disbursements made by the association for the year which is certified by White, Hickox & Co., certified public accountants, Boston, Mass., in accordance with the vote of the association at the last annual meeting relative to auditing financial accounts.

Respectfully submitted,
A. F. BURGESS, *Secretary*

REPORT OF AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

MELROSE, MASS., November 14, 1930

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

For the period from December 1, 1929 to November 14, 1930

	Total	Journal	Association	Index I and II	Index III	Index IV
Balance, November 30, 1929	$7,542.09	$4,375.11	$1,613.69	$1,546.44	$ 6.85	—
Income						
Sales	585.50	—	—	126.50	121.00	$338.00
Transfer from Index III	125.00	—	—	125.00	—	—
Subscriptions, advertising and miscellaneous	7,935.76	7,935.76	—	—	—	—
Dues and separates	1,603.81	—	1,603.81	—	—	—
	17,792.16	12,310.87	3,217.50	1,797.94	127.85	338.00
Expenses						
Printing	5,143.02	5,134.02	—	—	—	9.00
Halftones and engravings	710.26	710.26	—	—	—	—
Postage	351.21	266.86	79.27	2.48	2.60	—
Supplies and Stationery	162.30	90.63	71.67	—	—	—
Telegraph, Freight and Express	10.78	5.33	5.45	—	—	—
Editor	200.00	200.00	—	—	—	—
Clerical work Editor's office	190.00	190.00	—	—	—	—
Business Manager	100.00	100.00	—	—	—	—
Clerical work	277.50	183.00	94.50	—	—	—
Transfer to Permanent Fund	1,800.00	800.00	1,000.00	—	—	—
Refund on subscriptions	27.05	27.05	—	—	—	—
Returned check	28.00	28.00	—	—	—	—
Stenographic report	175.28	—	175.28	—	—	—
Expenses Pacific Coast Branch	23.02	—	23.02	—	—	—
Expenses Cotton States Branch	28.28	—	28.28	—	—	—
Secretary	100.00	—	100.00	—	—	—
Bond for Secretary	12.50	—	12.50	—	—	—
Transfer Life Membership to Permanent Fd.	100.00	—	100.00	—	—	—
Transfer to Index I & II	125.00	—	—	—	125.00	—
Total Expenses	9,564.20	7,735.15	1,689.97	$ 2.48	127.60	9.00
Balance November 14, 1930	$8,227.96	$4,575.72	$1,527.53	$1,795.46	$ .25	$329.00

The above balance is on deposit at the First National Bank, Malden, Mass.

Checking Account	$3,227.96
Certificates of Deposit	5,000.00
	$8,227.96

PERMANENT FUND AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
For the period from December 1, 1929 to Novemner 14, 1930

Balance December 1, 1929 per previous report			$ 8,096.54
Additions			
Interest from securities	$ 113.75		
Interest from savings deposits	400.14		
Interest from Index, JOURNAL and Association accts.	234.32		
Life Membership Fee	100.00		
Transfer from JOURNAL account	800.00		
Transfer from Association account	1,000.00	$2,648.21	
Less: Writing off premium and accrued interest on Province of Ontario Bonds purchased		95.83	2,552.38
Balance November 14, 1930			$10,648.92
Invested as follows:			
4¼% United States Liberty Bond—at par			$ 1,500.00
5% Province of Ontario Bonds—at par			2,000.00
Melrose (Mass.) Savings Bank			2,877.76
Melrose (Mass.) Trust Company—Savings Department			2,246.16
Malden (Mass.) Savings Bank			2,025.00
			$10,648.92

CERTIFICATE

We have examined the records, books and accounts of the Secretary of the American Association of Economic Entomologists for the period from December 1, 1929 to November 14, 1930, inclusive.

All recorded income was traced into the Association's bank account, all disbursements were found to be supported by proper vouchers. The cash balances at the end of the period were verified with the depositories.

The Permanent Fund securities were counted, and the deposits in Savings Banks were verified. We satisfied ourselves that all income earned by this Fund was properly accounted for, and all transfers from other sources were authorized.

Boston, Mass., December 12, 1930.

WHITE, HICKOX & COMPANY.
Certified Public Accountants

It was moved and seconded that the report be accepted and published.

Secretary Burgess explained that at the time of closing the books 130 members had subscribed for Index No 4 of the literature on Economic entomology, copies of which have just been received from the printer, and urged that a larger number of members support this publication.

PRESIDENT FRANKLIN SHERMAN: The report of C. W. Collins, Business Manager of the Journal of Economic Entomology, will now be read by the Secretary.

REPORT OF BUSINESS MANAGER, JOURNAL OF ECONOMIC ENTOMOLOGY

At the last annual meeting the Association elected a new Secretary but continued the undersigned in the capacity of Business Manager, hence the following report.

In that the JOURNAL accounts are so closely linked with those of the Association, it

was impractical to open a separate set of books and all funds received during the year have been turned over to the Secretary for his accounting, a statement of which is included in his report.

Volume 23 of the JOURNAL OF ECONOMIC ENTOMOLOGY has just been completed and contains 1036 printed pages, compared with 1019 in the previous volume. For the first 16 years the JOURNAL contained an average of 515 pages; in the seven years 1924 to 1930 inclusive, the pagination has gained an average of 390 or 76% over the 16-year period. This gain in the size of the JOURNAL has been accomplished slowly and steadily over a period of years without increasing the subscription rate. This has been made possible by the co-operation of members subscribing liberally and the increasing demand for the publication from foreign countries.

Complete sets of the JOURNAL are still available, excepting Volume 1 (Nos. 2, 5 and 6 being out of print). It was not necessary to raise the price of any back volume during the current year although the stock of some volumes has become rather low and undoubtedly it will be necessary to increase the price another year. The cost of back volumes is carried in the JOURNAL advertisement appearing in each issue. Members desiring to complete their sets should take advantage of the present rates before the supply becomes further exhausted.

During the year suggestions came to the Business Manager of the possibility of developing a Directory of "Supplies and Equipment Used and Recommended by Entomologists." Small advertisements were solicited, not exceeding 10 agate lines per column (page being divided into two columns), for which a charge of $25.00 was made for single advertisement, with $10 for each additional ad from the same company. This Directory was classified under various headings, including "Insecticides, Adhesives and Spreaders," "Spraying and Dusting Machinery," "Laboratory and Museum Supplies," "Entomological Publications" and "Tree Experts." It was started in the October issue of the JOURNAL and at this writing (December issue) a total of $520 has been contracted for the Directory to run for one year from first listing. This method of advertising shows some promise and may supersede some of the regular page advertising of the JOURNAL.

The following table shows the total domestic and foreign subscribers in 1913, 1923, 1929 and 1930:

	1913	*1923*	*1929*	*1930*
Alabama	3	9	8	10
Arizona	7	8	17	21
Arkansas	2	4	9	8
California	34	67	133	144
Colorado	7	12	15	15
Connecticut	10	15	26	28
Delaware	3	3	8	8
District of Columbia	50	55	60	61
Florida	7	15	30	33
Georgia	6	10	15	17
Idaho	2	6	8	11
Illinois	30	31	31	38
Indiana	16	15	26	25
Iowa	5	12	21	20
Kansas	16	16	24	25
Kentucky	4	5	8	8
Louisiana	12	17	30	33
Maine	5	7	11	9

	1913	1923	1929	1930
Maryland	11	14	22	24
Massachusetts	48	76	68	75
Michigan	15	10	27	26
Minnesota	10	14	13	16
Mississippi	4	22	35	36
Missouri	8	12	15	19
Montana	5	7	7	8
Nebraska	3	3	7	9
Nevada	1	2	3	3
New Hampshire	4	9	8	7
New Jersey	14	22	38	45
New Mexico	3	3	3	3
New York	52	69	88	93
North Carolina	6	8	20	19
North Dakota	0	1	2	3
Ohio	22	34	65	69
Oklahoma	2	5	6	8
Oregon	10	12	17	26
Pennsylvania	18	38	41	42
Rhode Island	3	7	4	4
South Carolina	4	2	11	12
South Dakota	1	2	2	4
Tennessee	6	11	18	18
Texas	16	21	50	61
Utah	8	9	17	21
Vermont	1	1	2	2
Virginia	7	16	22	23
Washington	8	8	20	21
West Virginia	5	5	5	5
Wisconsin	6	13	16	20
Wyoming	0	2	3	3
Total for U. S.	520	765	1135	1234
U. S. Insular Possessions and Cuba	26	—	—	—
Hawaii	—	11	12	17
Panama and Virgin Islands	—	2	1	1
Philippines	—	5	6	6
Porto Rico and Cuba	—	7	13	16
Canada	27	47	56	55
Foreign	132	183	346	347
GRAND TOTAL	705	1020	1569	1681

The foregoing table, together with those published in previous years, shows the following gains: 115 in 1925 over 1924; 98 in 1926 over 1925; 77 in 1927 over 1926; 89 in 1928 over 1927; 63 in 1929 over 1928 and 112 in 1930 over 1929.

Respectfully Submitted,

C. W. COLLINS,

Business Manager

Voted that the report be accepted.

PRESIDENT FRANKLIN SHERMAN: I will now read the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

Shortly after the beginning of the year Professor J. S. Houser was appointed as the representative of this Association to make local arrangements for the Cleveland meeting.

On February 6 and 7, 1930, as President of the Association, I attended the annual meeting of the Cotton States Branch, at Jackson, Mississippi. A large number of Entomologists were present and very profitable sessions were held. A field trip to the Bureau of Entomology Laboratory at Tallulah, Louisiana, gave the members present an opportunity to observe the research work which was being conducted on cotton insects.

In accordance with the vote of the Association at the last meeting, an invitation was extended to Doctor W. R. Thompson of Great Britain to attend this meeting and deliver an address on the biological control of insects. It was not possible for him to accept but he expects to visit Canada and the United States next summer and inspect many of the research laboratories at that time.

During the summer Professor W. C. O'Kane asked to be relieved as chairman of the Committee on Training of Entomologists and Doctor C. J. Drake was designated to fill this position.

A letter was sent to the Smithsonian Institution urging that a large edition be published of the History of Applied Entomology which had been prepared by Doctor L. O. Howard in order that copies might be available for distribution to Entomologists.

An invitation was received that this Association be represented at the 50th anniversary of the establishment of the New Jersey Agricultural Experiment Station on October 8, 1930. Professor P. J. Parrott was appointed to act in this capacity.

The Executive Committee approved the transfer to the permanent fund of $1000 from the Association fund and $800 from the JOURNAL fund; action on the latter proposal was recommended by the Editorial Board of the JOURNAL OF ECONOMIC ENTOMOLOGY.

The financial reports of the Secretary and the Trustees of the Permanent Fund have been audited by a certified public accountant, in accordance with the action taken at the last annual meeting.

Certain proposed amendments to the International Rules of Biological Nomenclature submitted to our Association by Dr. C. W. Stiles, were referred for final recommendation to Dr. Harold Morrison in charge of Taxonomic Investigation of the U. S. Bureau of Entomology with authority to enlist the aid of others to serve with him. Their report was written after consultation with taxonomic experts of the Bureau and U. S. National Museum, which report was then forwarded to Dr. Stiles. This report has been approved by the Executive Committee and it is recommended that an abstract be published in the JOURNAL OF ECONOMIC ENTOMOLOGY.

A communication from the chairman of the Division of Biology and Agriculture of the National Research Council, relative to representation of this Association in that body, has been referred to Dr. W. A. Riley, who is our representative in that Division with the request that he take appropriate action.

The Executive Committee recommends that a communication received from the Genetics Section of the A. A. A. S. relative to the formation of a National Biological Society, be referred to a special committee to be appointed by the President with instructions to secure more information as to the scope and special purpose of the proposal and report to the Association.

We recommend that the President of this Association for 1931 be requested to consider arrangements for the presentation of a feature address which will be of special interest to our members and that one morning session, or as much thereof as necessary, be devoted to that purpose.

It is recommended that in view of the distinguished service rendered by Dr. L. O. Howard to the science of Entomology, that the committee on Membership be requested to recommend that his dues to this Association be remitted and further, that he be furnished with the issues of the JOURNAL OF ECONOMIC ENTOMOLOGY as published.

The Executive Committee approves the proposal of the Eastern Branch that each officially recognized Branch of the parent Association be allowed the publication of 50 pages in the JOURNAL OF ECONOMIC ENTOMOLOGY of its annual proceedings without charge to the Branch; that the next 50 pages, or portion thereof, if any, be published by the JOURNAL at a price of $1.50 per page, to be defrayed by the Branch; that matter in excess of 100 pages be published at a price of $3 per page, to be paid by the Branch concerned, provided that this arrangement shall be effective for each Branch as soon as it is officially approved by the Branch concerned.

The Committee recommends the following changes in the Constitution and By-Laws of this Association to provide for a Board of Trustees for the permanent fund, and defining their duties, the establishment of this fund by Constitutional enactment and the election of the Editorial Board of the JOURNAL in the same manner as other offices of the Association.

Amend Article 3, Section 1, of the Constitution to read as follows: The officers shall consist of a President, one Vice-President and an additional Vice-President for each Branch or Section, who shall be elected annually, a Board of Trustees of the Permanent Fund and a Secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent on their respective offices and as defined in the By-Laws. The President and Secretary of the Association, together with three members, one of whom shall be elected annually for a term of three years, shall constitute the Executive Committee, provided also that the retiring President shall retain membership on the Executive Committee for two years after the expiration of his term and the ex-President who next preceded him shall be a member of the Committee for one year. The Executive Committee shall pass on all urgent matters that cannot be deferred until the annual meeting. The President shall not hold office for two consecutive terms. The Board of Trustees of the Permanent Fund shall consist of the President, Secretary and three members at large who shall be elected for terms of three years, so arranged that one member shall be elected annually.

Article 4, to be renumbered and read as follows:

FUNDS

Section 1. The general funds of the Association shall be entered and accounted for in such a manner that the financial condition of each activity can be easily determined. A permanent fund shall be established which shall include all donations, bequests, fees for life membership and such other property or funds as may be added to it by transfer. The principal of this fund shall be invested and shall not be expended without recommendation of the Executive Committee and the approval of the Association at the annual meeting, notice of such action to be given in the call for said meeting. The interest in any year may be used to meet necessary expenses

of the Association on approval of the Executive Committee and if not so expended shall be added to the principal.

Re-number Article 4 to read Article 5 and re-number Article 5 to read Article 6.

Amend By-Laws by inserting a Section in Article 2 numbered Section 3, to read as follows: The trustees of the permanent fund shall have charge of the money or other property placed in such fund and shall be authorized to invest it in securities considered legal for trust funds.

Re-number Section 3 to read Section 5, and amend Section 4 to read: Publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an Editor, an Associate Editor and a Business Manager to be elected annually, and an Advisory Committee of six members which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above stated editorial board.

For the Committee,
FRANKLIN SHERMAN,
President

It was voted that the report be accepted and the recommendations adopted as read.

PRESIDENT FRANKLIN SHERMAN: The next item is the report of the Representative to the National Research Council.

REPORT OF THE REPRESENTATIVE OF THE NATIONAL RESEARCH COUNCIL

The Division of Biology and Agriculture of the National Research Council is constituted of six members-at-large, and of representatives of eight groups. Of these groups, number VIII includes the American Association of Economic Entomologists, the Entomological Society of America and the American Society of Mammology.

The group representative, whose term expires in 1931, is William A. Riley, the alternate J. E. Graf. Advisory representative, from the Entomological Society of America, is Frank E. Lutz.

The field which is covered by the Division is a vast one and many of its activities are of far reaching importance. As pointed out in the last report of the chairman several projects originated by the Division or developed out of the work of divisional committees are now, in somewhat varying measure, conducted independently. Such projects are: the Barro Colorado Island Biological Laboratory, Biological Abstracts, the Commission on the Standardization of Biological Stains, the National Research Fellowships in the Biological Sciences, and the Tropical Plant Research Foundation.

The Barro Colorado Island Biological Laboratory is now in its seventh year and is constantly demonstrating its value for research on the zoology of the tropics. Mr. Zetek's last report lists 118 papers based on work done there. A very considerable number of these relate to insects and other arthropods.

The publication of the Index number of the first volume of Biological Abstracts affords the first opportunity to evaluate this stupendous undertaking, whose success will be of untold value to biological sciences throughout the world.

The Commission on the Standardization of Biological stains, like the two projects above mentioned is affiliated with but no longer under the Division. It is continuing

its important work of testing and certifying new dyes. Among these is an American-produced haematein which is not only superior to the foreign supply but distinctly lower in price. The Committee is still publishing the journal, Stain Technology, and has issued a second edition of the book "Biological Stains."

A relatively new activity is that of the Committee on the Effects of Radiation on Living Organisms. Under the very efficient leadership of Dr. W. C. Curtis this work has developed rapidly and its research budget for the current year provides $23,986.20 for the support of investigations to be conducted in eighteen institutions on the biological effects of light, X-rays, and radium emanations. A sub-committee is making a survey of research under way in this general field and is expected to make recommendations regarding the most profitable lines of attack upon the problems of radiation in its biological aspects. As insects afford excellent material for experimental work in this field, and as there is a belief in many sections, that results of economic importance may be obtained, it is desirable that entomologists interested in such work should be in touch with the Committee.

A more detailed report of the activities of the Division of Biology and Agriculture has been filed with our Secretary by the Secretary of the Division. It is the belief of your representative that the feasibility of its publication as a whole should be considered by the editor of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Voted, that the report be accepted.

It was voted on motion of W. A. Riley that the President appoint an elector to represent this Association in selecting a representative for the entomologists group in the National Research Council.

PRESIDENT FRANKLIN SHERMAN: Next is the report of the governors of the Crop Protection Institute.

REPORT OF BOARD OF GOVERNORS OF THE CROP PROTECTION INSTITUTE

FOR THE YEAR 1930

During the year 1930 the research work of the Institute has proceeded in about the same scope as during the last two or three years. Projects have been under way in fifteen states, as follows:

Washington, California, Kansas, Iowa, Wisconsin, Illinois, Ohio, Kentucky, New York, Connecticut, New Hampshire, New Jersey, Delaware, Maryland, Florida and Texas. A total of nineteen men have been employed on the research staff, either part time or full time.

The major subjects of research have included the following:

Oil sprays for codling moth; control of animal parasites; household sprays of kerosene base containing pyrethrum extracts and other toxic substances; industrial tape for nursery grafts; flotation sulphur; horticultural sprays with a base derived from petroleum distillates; pyrethrum culture; utilization of rotenone; accumulation of oil in plant tissues; control of oriental fruit moth by spraying; utilization of cocoanut oil emulsions; methods of extraction of pyrethrum.

Bulletins issued, or in press, by the Institute, in 1930, include the following:

No. 25, "Studies upon a Bacteriophage Specific for *Pseudomonas tumefaciens*," by Dr. J. H. Muncie and Dr. M. K. Patel.

No. 26, "Crowngall of *Rumex crispus* L. and *Rheum raponticum* L.," by Dr. J. H. Muncie.

No. 27, "Fasciation of Sweet Peas," by Dr. J. H. Muncie and Dr. M. K. Patel.

No. 28, "The Control of Certain Fruit Diseases With Flotation Sulphurs," by M. A. Smith.

No. 29, "Studies of Crowngall Overgrowth and Hairyroot on Apple Nursery Stock," by J. H. Muncie and Ross F. Suit.

No. 30, "Influence of Environment on the Callusing of Apple Cuttings and Grafts."

No. 31, "Monochlornaphthalene as an Insecticide."

The work of the Institute continues to yield results that may fairly be looked upon as practical and concrete accomplishments. Among others the following may be noted:

Definite schedules of treatment whereby saturated oils are adapted to use for controlling animal parasites.

Determination of an important factor bearing on stability of pyrethrum extracts.

Practical utilization of a new material originated by the Institute and adapted to control of some important plant diseases carried on seeds.

Elimination of the larger percentage of costly overgrowths in apple grafts through utilization of industrial tape as a practical process.

Development of combination sprays containing so-called "summer oil" and a fungicide.

Development of a wetting agent which promises to give stability to pyrethrum extracts.

W. C. O'KANE,
Chairman, Board of Governors

Voted, that the report be accepted.

PRESIDENT FRANKLIN SHERMAN: We will now listen to the report of the Scientific Trustee of the Tropical Plant Research Foundation.

REPORT OF THE TRUSTEE, TROPICAL PLANT RESEARCH FOUNDATION

During the past year the affairs of the Foundation have been in a somewhat unsettled stage, due in large part to the death of the Director, whose death in the prime of life, was a serious loss for the Foundation which he had nurtured from its beginning. Furthermore, the serious depression in the sugar industry has made the prospect of any expansion of work in Cuba impossible, but it is hoped that arrangements may be made so as to avoid serious loss of results in the experimental work already in progress. A letter from the local director, Professor D. L. Van Dine, from which I may make some brief quotations indicates that there may be a necessity of dropping some of the scientific workers and he is quite concerned as to the opportunities for employment for these men at other places. He says "The work has been so arranged that special consideration can be given to the soil insects which as a group are responsible for serious losses and a contributing factor in cane failure. In this problem the grass-root-mealybug *Ripersia radicicola* Morr. is very conspicuous and also certain species of wireworms. Another class of insects which have been studied is the grass worms which are seasonally injurious in the cane fields. The work to be continued will relate particularly to the soil insects, not only because we

know so little about them, but because they fit into the program of the Station as a whole which we will make every effort to maintain.*** Our work in insect control, with special reference to the moth stalkborer, was tending definitely toward the utilization of parasites since we understand the plantation operations which might affect the abundance of this insect. We plan to continue studies on the parasites which occur in Cuba. It is apparent that, under natural conditions, their effectiveness is not sufficient to reduce the stalkborer below the point where the loss is very serious. It may be that their benefit can be increased by transplantings from one locality to another or by redistribution within a zone, and this will be attempted if we find the opportunity to do so. The question of foreign introductions, however, bringing in other species to supplement the work of those which we have already, is one which requires both time and money beyond our present means and cannot be considered under our present program."

It is evident that a serious effort is made to avoid loss of scientific results and that the entomological services will be maintained to the extent possible. Also it is to be hoped that conditions in the near future may permit of a continuance of this work in an efficient manner. The Foundation has had some intimations of support from other sources but these are not at present in form to be given out in detail.

Respectfully submitted,
HERBERT OSBORN, *Trustee, Tropical Plant Research Foundation*

Voted, that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: As no report has been received from the representative of the Council of the Union of Biological Societies, we will now hear the report of the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

Your committee begs to report that in conformity with instructions received at the last regular meeting of the Association, a list of names for thirty-six insects was submitted to the Association for approval. Of this list, twenty-three names received the necessary vote for adoption and the details of the vote with the approved names was published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 23, No. 3, June 1930, page 639.

During the past year, the committee has received many requests for a complete list of the common names that have so far been adopted by the Association. The necessity of looking through the many numbers of the JOURNAL for these partial lists seems to be the greatest difficulty at the present time. Your committee feels that a complete list should be issued but is not making a formal recommendation to this effect in this report as it does not wish to embarrass the management of the JOURNAL OF ECONOMIC ENTOMOLOGY. It does, however, suggest that this matter be given consideration by the Advisory Committee. With this thought in mind, your committee is submitting herewith a list of common names for your approval. This is the largest list that has been submitted since the original list in 1925, in order that, if the publication of a separate complete list is authorized this year, it will be comprehensive enough to suffice for several years.

The committee recommends that it be authorized to follow the procedure adopted last year of submitting this list of names to the active members of the Association,

following these meetings, for approval or disapproval and that if 20 per cent, or more, of the votes cast for any given name are in opposition to that name, it will be rejected, and that all other names will be considered as accepted.

The committee further recommends that the names so approved be published in the JOURNAL either as the sixth supplement to the list of common names, or incorporated in a complete list of approved names.

J. A. HYSLOP, *Chairman*
E. O. ESSIG
F. C. BISHOPP
H. B. HUNGERFORD
H. G. CRAWFORD
Committee

Several questions were asked by the members concerning this report, one of which was as to the possibility of the common names which had been adopted being reviewed by the committee and replaced by more appropriate names, and also whether in special cases an alternate common name could be used for the same species in different parts of the country. Mr. J. A. Hyslop stated that he saw no objection to either of these proposals and it was voted that the committee should be authorized to consider proposals of this nature, after which the report was accepted.

PRESIDENT FRANKLIN SHERMAN: As there is no report to be submitted by the Committee on Endowment, we will now listen to the report of the Editorial Board on the Index of Economic Entomology.

REPORT ON INDEX IV TO AMERICAN ECONOMIC ENTOMOLOGY

The compilation of the Index was made possible through the courtesy of Dr. C. L. Marlatt, Chief of the U. S. Bureau of Entomology. The work was done by Miss Mabel Colcord, Librarian of the Bureau, and a number of assistants with the cooperation of Bureau experts in various lines. The 1905 pages of manuscript were received by the editor early in September, and in October copy was sent to the printer, the last proof being returned December 9. Completed copies were distributed the latter part of the month. It may not be out of place to call attention to the fact that Indexes 1 to 4 cover the literature of 25 years.

The Index was prepared along substantially the same lines as its three predecessors, marginal symbols or letters being used to indicate common names approved by the Association, articles containing descriptions of new species, illustrations and bibliographies. Condensed citations are given in a number of cases where species were of minor economic importance or the references of such a character as to permit this. An edition of 1000 copies was printed. The financial details appear in the Report of the Secretary of the Association.

The Committee would remind members of the Association of their indebtedness to Dr. Marlatt and those members of the Bureau staff who have rendered such material assistance in the preparation of the Index, especially is this true of Miss Colcord and her assistants who did so much of the work.

The committee recommends that the Editorial Board of the JOURNAL be continued in charge of the Index and that it be instructed to report at the proper time upon the possibilities of publishing an Index for the five year period ending December 31, 1934.

Respectfully submitted,
E. P. FELT
D. M. DELONG
C. W. COLLINS
Committee

By vote of the Association the report was accepted, and appreciation extended to the Committee for the preparation of Index IV.

PRESIDENT FRANKLIN SHERMAN: We will now listen to the report of the Board of Trustees for the Permanent Fund.

REPORT OF THE BOARD OF TRUSTEES OF THE PERMANENT FUND

In accordance with the suggestion made at the last annual meeting, the trustees of the permanent fund considered very carefully early in the year the matter of investing the amount on hand where a larger return might be realized.

After considerable correspondence it was decided that a portion of the fund should be invested in bonds and two $1,000 Province of Ontario 5% bonds were bought and $2,000 of the balance in the Melrose, Mass., Savings Bank was placed on deposit in Malden, Mass., Savings Bank where dividends at the rate of 5% have been paid for a number of years.

The trustees were of the opinion that safety rather than a high interest rate should be the guiding principle in investing this fund and it is believed that this has been accomplished.

Most of the funds transferred from the Association account have been deposited in the Melrose Trust Co.

There was paid into this fund during the year all interest on deposits and the fee of $100 for one life membership. By authority of the Executive Committee of the Association $1,000 was transferred to this fund from the Association fund and $800 from the JOURNAL fund. The latter transfer was first approved by the Editorial Board of the JOURNAL OF ECONOMIC ENTOMOLOGY.

PERMANENT FUND AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
For the period from December 1, 1929 to November 15, 1930

Balance per previous report, November 30, 1929			$ 8,096.54
Additions			
Interest Received:			
Liberty Bonds—4¼%	$ 63.75		
Province of Ontario—5%	50.00		
Bank Deposits	338.30	$ 452.05	
Received from Secretary:			
Interest on Bank Deposits	296.36		
One Life Membership Fee	100.00		
Transferred from:			
JOURNAL Account	800.00		
Association Account	1,000.00	2,196.36	
		$2,648.41	
Less: Premium on Province of Ontario Bonds written off		95.83	2,552.58
Balance, November 15, 1930			$10,649.12

Invested as Follows:

4¼% United States Liberty Bonds—at par	$ 1,500.00
5% Province of Ontario Bonds—at par	2,000.00
Melrose (Mass.) Savings Bank	2,877.76
Melrose (Mass.) Trust Company—Savings Dept.	2,246.36
Malden (Mass.) Savings Bank	2,025.00
	$10,649.12

Respectfully submitted
A. F. BURGESS, *Chairman*
FRANKLIN SHERMAN
C. W. COLLINS
E. N. CORY
R. W. DOANE

Voted, that the report be accepted.

PRESIDENT FRANKLIN SHERMAN: The next item is the report of the Committee on National Museums.

REPORT OF THE COMMITTEE ON NATIONAL MUSEUMS

Entomologists in Canada and the United States should keep in mind that the National Museums must continue to grow and develop along entomological lines. Each one should consider himself, in a degree, responsible for this continued growth and development.

In the United States, each member of Congress should be informed, from year to year, by the entomologists in their respective states of the economic value of the Division of Insects of the National Museum and the Division of Taxonomy of the Bureau of Entomology, U. S. Department of Agriculture. These organizations are rendering an invaluable service but deserve more adequate support to properly care for the demands for assistance from entomologists throughout the nation. They should have on their combined staffs, specialists in each group of insects. They should at all times be in a position to call to their ranks out-standing taxonomic workers and to acquire important entomological collections. Their staffs should be so increased that practically all insects that are sent to them for identification may be given prompt attention. They should have sufficient workers so as to put into print their researches for the benefit of other workers.

Your committee has been gratified to learn of the addition, during the past year, of the Barnes' Collection of Lepidoptera to the U. S. National Museum and of the addition of the well-known hemipterist, H. G. Barber, to the staff of specialists. It is hoped that this is an indication that additional specialists as well as additional collections will be added from year to year.

R. W. HARNED
H. H. KNIGHT
E. C. VANDYKE
A. W. BAKER
J. J. DAVIS, *Chairman*

Voted, that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: I understand there is no formal report to be submitted by the Coordinating Committee on Program, but this Committee has functioned and the program has been arranged

without material conflict with that of the Entomological Society of America.

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints.

REPORT OF COMMITTEE TO FORMULATE PLANS FOR INVESTIGATIONS OF THE CODLING MOTH FROM BIOLOGIC AND CONTROL STANDPOINTS

As a part of the activity of the Codling Moth Committee, a conference was held in Washington, D. C., February 10, 1930. This was attended by some 50 entomologists and others interested in the codling moth and spray residue problem. The minutes of this conference were later circulated among the entomologists present, and have been available to others upon request.

Because of the likelihood that no conference would be held this winter, the Committee has assembled a more complete and informative report than last year. A circular letter was addressed to 34 entomologists known to be actively investigating the codling moth problem. The following list includes those who have sent in information in response to the request, the nature of their contributions being indicated:

A. J. Ackerman, U. S. Bureau of Entomology, Bentonville, Ark.
Field tests of manganese arsenate, nicotine-oil, pyrethrum-oil, and nicotine tannate, as substitutes for lead arsenate against second brood and later worms. (Interpretation of results made difficult by severe hail injury to the fruit in the experimental orchard.)

C. H. Alden, Georgia State Board of Entomology, Cornelia, Ga.
Tests of chemically treated and untreated bands; biological notes; propagation and utilization of *Trichogramma;* spray residue situation.

Luther Brown, U. S. Bureau of Entomology, Takoma Park, Md.
Rearing of codling moth parasite material; rearing technique for such species as *Ascogaster carpocapsae.*

E. N. Cory, P. D. Sanders, University of Maryland, College Park, Md.
Field tests of barium fluosilicate; banding, including tests of chemically treated bands; biological notes; residue situation.

Leroy Childs, Hood River, Oregon.
Field tests of oil sprays, oil-lead arsenate, and rotenone; chemically treated bands.

C. R. Cutright, Agricultural Experiment Station, Wooster, Ohio.
Field tests of summer oils, and oil-nicotine sprays; chemically treated bands; seasonal notes; residue situation.

J. J. Davis, Purdue University, Lafayette, Ind.
Field tests of summer oils, oil-nicotine, and oil-pyrethrum; chemically treated bands; residue situation.

C. O. Eddy, Clemson Agricultural College, Clemson College, S. C.
Tests of chemically treated bands.

J. R. Eyer, Agricultural Experiment Station, State College, N. M.
Field tests of oil sprays; chemically treated bands; bait trap studies; biological control; residue situation.

W. P. Flint, State Natural History Survey, Urbana, Ill.
Field tests of oil sprays, oil-nicotine, oil-derris; chemically treated bands; *Trichogramma* rearing; residue situation.

P. M. Gilmer and E. W. Howe, U. S. Bureau of Entomology, Wichita, Kans.
Field tests of oil-nicotine, oil-derris, and oil-pyrethrum combinations; lead arsenate dosage; spray timing; tests of spreaders; chemically treated bands; seasonal notes; studies of moth distribution in the orchard.

Leonard Haseman, University of Missouri, Columbia, Mo.
Field tests of fluorine compounds, oil and oil-nicotine; chemically treated bands; biological notes; residue situation.

T. J. Headlee, Agricultural Experiment Station, New Brunswick, N. J.
Tests of white oil-pyrethrum, nicotine tannate, pineol soluble; chemically treated bands; biological notes; residue situation.

W. S. Hough, Winchester Field Laboratory, Winchester, Va.
Studies of biological strains of the codling moth; residue situation.

Dwight Isely, University of Arkansas, Fayetteville, Ark.
Residue situation.

F. H. Lathrop and R. F. Sazama, U. S. Bureau of Entomology, Vincennes, Ind.
Laboratory tests of numerous insecticides; biological observations.

Geo. M. List, Agricultural Experiment Station, Fort Collins, Colo.
Propagation and utilization of *Trichogramma;* studies of chemically treated bands.

E. J. Newcomer, U. S. Bureau of Entomology, Yakima, Wash.
Field tests of nicotine-oil, nicotine tannate-oil; manganese arsenate, barium fluosilicate; laboratory tests of numerous fluorine compounds; chemically treated bands; residue situation.

Franklin Sherman, Michigan Agricultural College, East Lansing, Mich.
Tests of oil-nicotine combination, white oil and other oils; residue situation.

E. H. Siegler, U. S. Bureau of Entomology, Takoma Park, Md.
Chemically treated bands, including reports from a number of collaborators.

A. Spuler, Washington State College, Pullman, Wash.
Field tests of fluorine compounds, oil-nicotine, nicotine tannate and other insoluble nicotine compounds; chemically treated bands; residue situation.

L. A. Stearns, Agricultural Experiment Station, Newark, Del.
Laboratory tests of nicotine tannate; field tests of chemically treated bands; biological notes; residue situation.

B. G. Thompson, Agricultural Experiment Station, Corvallis, Ore.
Field tests of barium and sodium fluosilicates, pyrethrum and nicotine-oil combinations.

H. N. Worthley, Agricultural Experiment Station, State College, Pa.
Chemically treated bands.

M. A. Yothers, U. S. Bureau of Entomology, Wenatchee, Wash.
Chemically treated bands; treatments for hibernating larvae on tree trunks.

As may be expected from work conducted in many different localities, the results show a certain amount of diversity. It has not appeared feasible in this report to attempt an explanation of the differences which have occurred.

Seasonal Conditions

The season of 1930 was characterized by extreme drought and heat in most of the fruit regions east of the Rocky Mountains. This resulted in a generally heavy codling moth infestation (Alden, Cutright, Gilmer, Hough, Lathrop, Ackerman, Stearns). A partial fourth brood developed in North Georgia and Kansas (Alden, Gilmer), and a destructive third brood in Delaware (Stearns), southern Ohio (Cutright) and as far north as St. Joseph, Missouri (Haseman). In the Northwest, the infestation was about normal, being much less severe than in 1929, when it was abnormally high (Newcomer).

Spray Residue

In the Northwest, residues were somewhat higher than usual. Spuler reported as high as .09 grains As_2O_3 per pound of fruit from a seven-spray schedule of lead arsenate 1–½ to 50. Newcomer reports residues as high as .15 As_2O_3 per pound, and states that the fruit in the Yakima Valley would average .05 grains per pound. In the Yakima and Wenatchee valleys, 99 per cent of the fruit was cleaned by washing. Considerable difficulty was experienced in cleaning the more heavily sprayed fruit. This difficulty was partially overcome by heating the cleaning solution, by the use of stronger acid or alkali, or by the addition of salt and kerosene emulsion as developed by the Bureau of Plant Industry.

East of the Rocky Mountains the residue likewise averaged greater than normal, because of various factors. On account of the lack of rainfall, a more extended spray program was followed in many orchards. The fruit averaged smaller in size because of lack of moisture. These factors, together with the further reduction in the domestic tolerance, extended the spray residue problem to sections which had been hitherto exempt. Washers are being installed in a number of the Middle Western and Eastern orchards.

Insecticide Investigations

Manganese Arsenate—Manganese arsenate was tested in Washington (Spuler, Newcomer) and in Arkansas (Ackerman). Poor control resulted from these tests.

Barium fluosilicate 2–50 gave results in several field tests at Yakima, Wash., equivalent to those obtained with lead arsenate 1–½ to 50 (Newcomer). Cory reports that one application of barium fluosilicate following the regular lead arsenate schedule gave an additional 7 per cent of worm-free fruit. Spuler and Thompson, on the other hand, report poor control from the use of barium fluosilicate.

Haseman reports that different brands of fluosilicates, as well as synthetic cryolite, failed to control the worms in tests conducted by the Horticultural Department of the University of Missouri. Poor results were also reported with sodium fluosilicate (Thompson), and potassium fluoaluminate (Spuler).

Oil-nicotine—Among the organic materials that have been used experimentally, chiefly against the second brood and later worms, the oil-nicotine combination appears for the most part to have given the best results. Spuler reports oil ¾ per cent plus nicotine sulphate 1 to 1600 equal to or better than lead arsenate 1–½ to 50. Sherman reported that a single application of oil-nicotine on early apples was more effective than a single application of lead arsenate, but less favorable results were obtained in tests on winter varieties of apple. Newcomer, Haseman, Ackerman, and Gilmer reported control of worms somewhat poorer than with the stand-

ard lead arsenate treatment. Flint reported results from oil 2 per cent, nicotine 1–1600, against the second brood, slightly poorer than those obtained with lead arsenate throughout the season, and no better than those obtained with oil 2 per cent without nicotine. Davis reports a control equivalent to that obtained with lead arsenate from second and third brood applications of white oil, 2 per cent with nicotine sulphate 1–1600, but not significantly different from results of applications of 2 per cent oil without nicotine. Thompson reports unsatisfactory results with the oil-nicotine combination.

OIL-PYRETHRUM—Headlee reports good control from the use of ¾ pound of pyrethrum flowers per gallon of a 220-viscosity white oil, emulsified with powdered sweet skim milk, applied at the rate of .5 per cent of oil. This proved equivalent to lead arsenate in worm control, although the number of applications of the pyrethrum-impregnated oil was somewhat greater than the number of applications of lead arsenate. No direct injury developed in these tests, although in the plat which received eight applications of oil the foliage had a vegetative look. Fairly good results from the oil-pyrethrum combination were reported by Gilmer and by Davis, and poor results by Sherman, Ackerman and by Thompson. Lathrop and Sazama reported from laboratory tests that the oil-pyrethrum mixture was very effective when freshly applied, but lost its effectiveness on a few days exposure.

OIL-LEAD ARSENATE—The addition of summer oil emulsion to lead arsenate has continued to give, on the whole, slightly increased control (Newcomer, Spuler, Childs). Spuler reports that different brands of lead arsenate differ in their suitability for use with summer oils, those containing a deflocculater giving the best results in the combination.

OIL-DERRIS—Flint and Gilmer reported that the addition of derris extract, 1–800, to oil did not materially improve its effectiveness.

SUMMER OIL ALONE—In tests against second brood and later worms, Haseman and Davis both obtained results equivalent to those obtained with lead arsenate alone. In similar tests conducted under conditions of moderate worm infestation, Eyer obtained similar favorable results. Flint reported results with one brand of oil at 2 per cent against second and third brood worms nearly equal to those obtained with lead arsenate 1–50; somewhat poorer results were obtained with a second brand of oil. Counts in 62 commercial orchards in Illinois showed 15.1 per cent wormy fruit in orchards sprayed with lead throughout, and 16.2 per cent wormy in orchards receiving oil in second-brood sprays. Cutright reported that two applications of oil were slightly less effective than one of lead arsenate. Poor results with summer oils were reported by Ackerman, and there appeared to be a slight reduction in the size of the fruit. Ackerman also reports that one grower suffered serious fruit injury from three summer sprays of 2 per cent white oil emulsion. Considerable injury developed in the oil-sprayed plats in experiments conducted by Davis, but several abnormal climatic factors were considered largely responsible.

In the Hood River Valley (Childs) the Yellow Newtown is highly susceptible to oil injury, and no oil sprays can be generally recommended for this variety. If oil is used on Yellow Newtown, the viscosity should be not greater than 55.

NICOTINE TANNATE, ETC.—Headlee reports favorably on nicotine tannate, 7 to 9 applications of this material giving better results than 5 to 6 of lead arsenate; 3 applications of nicotine tannate for the control of first brood on early fruit gave

results equivalent to those obtained with 2 or 3 applications of lead arsenate. No foliage injury developed. There was also a considerable reduction in the amount of leafhopper damage late in the season.

Spuler reported that nicotine tannate (prepared just before application by mixing free nicotine with tannic acid) deposited more nicotine on the fruit than did the oil-nicotine sulphate combination, but this was not reflected in the degree of control obtained. Newcomer's results with nicotine tannate were about equal to those obtained with nicotine sulphate at an equivalent dilution (1–1200).

Stearns found in laboratory tests that nicotine tannate 8 pounds in 100 gallons showed a control equivalent to that obtained by lead arsenate 1–½ to 50 and with nicotine sulphate 1 to 800.

Small-scale laboratory tests have been conducted with other insoluble nicotine compounds (Lathrop and Sazama; Spuler).

ROTENONE—In small scale field tests rotenone has given very poor results (Spuler, Newcomer, Childs). In the laboratory results have varied from good (Spuler) to poor (Lathrop and Sazama). Newcomer reports that rotenone appears effective immediately after application, but loses its effectiveness rapidly on exposure.

TREATMENTS AGAINST HIBERNATING WORMS

Headlee reports that an application of pineol soluble made with a power sprayer in early spring reduced the first brood infestation 50 per cent. This difference disappeared the latter part of the season because of migration of the moths. Tests by Yothers gave varying degrees of kill.

MECHANICAL CONTROL

BANDING—Alden reports that a paper burlap band was found superior to ordinary burlap bands. Cory reported large catches of worms, as many as 1000 per tree in some cases where all of the rough bark was removed. Davis reports that 4-inch corrugated bands caught more worms than narrower ones, and that paper with the smaller corrugations was more satisfactory.

CHEMICALLY TREATED BANDS (Including information assembled by Mr. E. H. Siegler.)—The standard corrugated band saturated with beta-naphthol, 1 pound in 1½ pints of a 300 viscosity oil and similar bands with aluminum stearate ½ ounce in the preceding formula, have given a very satisfactory kill of worms in practically all tests reported by the men listed as contributing information on this point, practically no emergence taking place during the season. Flint reports successful treatment of bands by dissolving beta-naphthol in gasoline, and then mixing it with lubricating oil. One Illinois orchardist has used this method for the treatment of 20,000 bands. Some commercially treated bands gave poor results (Newcomer, Haseman) although other commercial bands have been very successful. Cutright reports that the beta-naphthol treated bands repelled 20 per cent of the larvae; and Childs found only 3 worms per band. Eyer also observed a slight repellency. Davis found that bands treated with alpha-naphthol caught nearly twice as many worms as those treated with beta-naphthol. Eyer found alpha-naphthalene to be more rapid in its action than beta-naphthol. With the exception of some injury in Ackerman's experiments, and a slight discoloration of the outer bark in a few other tests, no injury has appeared in this season's tests, although a final estimate cannot be made until spring.

BAIT TRAPS—Further investigations of bait traps have been conducted by Eyer. Increasing the surface area of the liquid beyond that provided by a 6-quart stewpan failed to increase the number of moths caught. A cone-shaped container 6 inches in diameter, and holding about 2 quarts of bait, has been found to be very efficient. Slowly fermenting baits appear to be more attractive than those which are fermenting rapidly.

SOIL TREATMENTS—Eyer tested soil fumigants against larvae concentrated in untreated bands at the bases of the trees, getting 100 per cent kill with calcium cyanide 8 ounces per tree; 90 per cent kill with carbon bisulphide, 12 ounces per tree, and 80 per cent kill with paradichlorobenzene, 6 ounces per tree. These tests were conducted under soil temperatures of 49°–54° F. The possibility is suggested of concentrating the worms into untreated banding material at the base of the tree, and later treating under a mound with an effective soil fumigant.

BIOLOGICAL NOTES

Studies of resistant strains of codling moth have been continued by Hough. After living under Virginia conditions for 3 years, Colorado larvae continued to demonstrate superior ability in entering sprayed fruit. This holds true for a number of spray materials, including cryolite, barium fluosilicate, rotenone, and lead arsenate. Crosses between the two strains continue to maintain an intermediate position.

Parasite rearing has been continued by Luther Brown of the Bureau of Entomology. He has also worked out rearing methods for the propagation of *Ascogaster carpocapsae* and *Phanerotoma tibialis*. Stearns reports that parasite activity is at a low ebb.

TRICHOGRAMMA UTILIZATION

Studies of *Trichogramma* rearing and utilization have been continued by List, by Flint, and by Alden. List reports that the problems in propagation of *Trichogramma* have been at least partly solved. The liberation of parasites in the orchard accelerates the increase in egg parasitism through the season. In spite of the high percentage of parasitism, however, the crops in the experimental orchards continued to be almost a total loss. Flint states that liberations made thus far have not shown a sufficient increase in parasitism to warrant the use of this control method. Alden reports that *Trichogramma* survives the winter in small numbers in most apple orchards in North Georgia and that the third brood of codling moth eggs sometimes becomes as much as 70 per cent parasitized.

Respectfully submitted,
A. L. QUAINTANCE, *Chairman*
LEROY CHILDS
G. A. DEAN
B. A. PORTER
P. J. PARROTT
W. A. ROSS
Committee

Voted that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Committee on Research Work on the Control of the European Corn Borer.

REPORT OF THE JOINT COMMITTEE ON EUROPEAN CORN BORER

Toledo, Ohio, September 23, 1930

The natural spread and increase of the European corn borer which might be anticipated in a normal season did not materialize in 1930. An abnormally small spread to new territory has occurred this season and in general there has been a decrease in borer population in the older infested regions of the one-brood area, although in Indiana and New York an appreciable increase. This situation has resulted from decidedly abnormal weather conditions, beginning when the moths first emerged, which checked flight and egg-laying. Later, seasonal conditions were responsible for a marked decrease below normal larval survival. In spite of the temporary check which has operated against the corn borer, there are a larger number of corn fields carrying a more uniform residual infestation, which forecasts a potentially serious increase and spread in 1931 if weather conditions are favorable.

The present infested area includes all of the corn-growing areas in Canada, excepting the western provinces; also 215,000 square miles in the United States including the southern two-thirds of New England, northern extremity of New Jersey, all of New York, three-fourths of Pennsylvania, the panhandle of West Virginia, practically all of Ohio, northeastern third of Indiana and nearly all of the agricultural portion of Michigan. In the north, and that territory in Connecticut west of the river adjacent to Long Island Sound the two-brooded form occurs, while in all other sections of the United States and all infested areas in Canada, excepting Nova Scotia and New Brunswick, only the one-brooded form occurs.

The fact that there has not been a normal increase and spread the past season emphasizes that we may anticipate seasons of increase and decrease in borer abundance as is true of other crop pests and that a temporary check such as the corn borer received in 1930 does not minimize the potential seriousness of this insect as a destructive agency. The Joint Committee, therefore, reiterates a statement made in its report a year ago, as follows:

"It, therefore, is still the opinion of the Joint Committee that, unless the corn borer is controlled, it will become one of the most destructive crop pests ever introduced into America. The situation, presenting as it does, the possibility of enormous agricultural losses, calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials."

The committee of entomologists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen, commends the efforts of all farmers practicing recommended control measures and those engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the continued development of the research, educational, and quarantine programs of the state and Federal Governments and earnestly recommends the appropriation of the funds needed to maintain and, if necessary, to expand them as suggested later in this report.

After careful investigation of the regulatory, research, and educational activities, the committee suggests and recommends:

1. Since the enforcement of quarantine regulations in the United States has undoubtedly been instrumental in preventing long distance spread of the insect in the past, that this activity of the Federal Governments of the United States and Canada, as well as the State and Provincial governments, be supported and encouraged by all agencies and individuals interested in the welfare of American Agriculture. Those activities should include, (a) thorough scouting, (b) careful clean-up of isolated infested areas, and (c) maintenance of quarantines.

2. That the extension agencies of the Federal governments of the United States and Canada and of the State and Provincial agricultural colleges, strengthen and coordinate their programs of education relating to the corn borer, extending these to conform with the spread and abundance of the insect and with the increased knowledge gained through research.

3. The entomological investigations now in progress should be continued and the following studies should be stressed because of their particular importance; (a) the expedition of parasite introductions and the development of artificial media for mass production of parasites, (b) the development of effective insecticides and their efficient application, (c) evaluation of the effect of environmental factors on the insect's activity.

4. While the development of *immune* varieties seems unlikely at this time, experiments point clearly to the probable development by breeding of high yielding *resistant* and *tolerant* varieties of corn which should be an important factor in control. To promote the development of such varieties, the corn breeding programs of the State and Federal governments should be continued and strengthened.

5. It is recommended that research with farm implements be continued by the individual state experiment stations as well as by the Federal departments of agriculture, and that such research be well supported. Investigations should include the further development of plows and plow attachments and attachments which can be applied to equipment already on the farm; also a further study of pickers with stalk handling attachments, rakes and other stalk handling equipment. The valuable assistance and cooperation given by manufacturers of farm equipment is highly commended.

6. Since the corn borer control practices developed and proposed may change the organization and income of the farm it is important that the relation of these practices to the entire farm business be determined and recommendations made for specific conditions. Proposals including changes in cropping systems, complete utilization of corn, substitute crops, changes in corn acreages, and labor and equipment costs should be worked out in line with the objective of maximum returns from farming.

7. Continued and further studies should be made on the influence of different degrees of corn-borer abundance upon; (a) feeding value of corn and the corn plant in different forms, (b) upon the yield of feed nutrients per acre, (c) comparative feeding value due to different methods of harvesting and preparing crop, (d) use and feeding value of substitute crops and (e) the influence of the corn borer and resultant control measures upon the cost of production and the quality of livestock products.

Respectfully submitted,

American Association of Economic Entomologists

G. A. DEAN — D. J. CAFFREY
L. CAESAR — T. J. HEADLEE
J. J. DAVIS

American Society of Agronomy

L. E. CALL — J. F. COX
W. L. BURLISON — R. M. SALTER
F. D. RICHEY

American Society of Agricultural Engineers

C. O. REED — A. L. YOUNG
T. W. PAUL — R. B. GRAY
R. D. BARDON

American Farm Economic Association

E. D. HILL — J. COKE
C. R. ARNOLD — LYNN ROBERTSON
C. L. HOLMES — R. R. HUDELSON

American Society of Animal Production

E. W. SHEETS — PAUL GERLAUGH
F. G. KING — G. A. BROWN
T. B. MORRISON

Voted, that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: The next item is the report of the Committee on Recommendations to Secretary of Agriculture with reference to Needs of Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or likely to be Introduced.

REPORT OF COMMITTEE ON RECOMMENDATIONS TO SECRETARY OF AGRICULTURE WITH REFERENCE TO NEEDS FOR FOREIGN STATIONS TO STUDY INSECT PESTS, PLANT AND ANIMAL DISEASES INTRODUCED OR LIKELY TO BE INTRODUCED

Your committee is unable to report any very definite results from the activities during the year and there seems to be rather slight prospect that we can expect any considerable expansion in this direction in the immediate future. Conditions in the Department of Agriculture and in the Bureau of Entomology seem to have required attention to other matters of apparently more immediate importance, and although we have been assured that funds might be available for some activities in this direction, there is no decided progress to report. The Committee still feel that there is an important function to be performed by laboratory or observation stations of a greater or less degree of permanence located at strategic points for the study of potential pests likely to be introduced into this country. However, we must bear in mind that there are difficulties connected with establishment of such stations that must be met and that may make progress necessarily slow.

The success of the Laboratories and Stations in operation for specific purposes in securing parasites or predators for the control of pests already introduced seems to give encouragement to the idea that a broader activity would be of distinct service. This appears to be particularly true for such stations as have been operating in Mexico city and in the Canal Zone and if these stations could be expanded or broadened in scope to provide for the temporary or permanent employment of specialists we believe that much valuable information concerning possible future pests or their ecological or biological relationships might be secured. We have the assurance that officials in the Department of Agriculture recognize the importance of this matter and are giving it their careful attention although no specific announcements are ready. It would perhaps be in order to express our appreciation of the interest of the Department officials who have given thoughtful consideration to our suggestion.

We recommend, therefore, that the Society continue its interest in this project and encourage activities in this direction whenever the opportunity seems appropriate.

HERBERT OSBORN, *Chairman*
GLENN W. HERRICK
E. O. ESSIG
Committee

Voted, that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: We will now listen to the report of the Committee on Training of Entomologists.

REPORT OF COMMITTEE ON THE TRAINING OF AN ENTOMOLOGIST

Three years ago a resolution was adopted by this Association providing for the appointment of a committee to study the problem of the training of an entomologist. Since then brief reports have been presented at the New York City and Des Moines meetings. As a preliminary to a thorough study of this problem and the various specialized activities which entomologists are called upon to undertake, a form letter was sent to a number of the outstanding research specialists in federal and state work and to a few college teachers. The questions asked of these men were stated in the following words:

If you had a perfectly free hand, what would you set up as the ideal training of a competent young man, to whom you would give four years of undergraduate, and three years of graduate work, to make him a specialist in ————————? (Name of special field, as *ecology*, *insect physiology*, etc.)

If you can let us have this in detail we shall be especially grateful; that is, if you can specify the amount of this or that subject, that you would have him take, both in entomology and in other subjects, and arrange it by years, if possible.

This report is a digest of the replies received from the foregoing letter together with numerous suggestions from several members of the association who met with the committee at the New York City, Des Moines and Cleveland meetings. Altogether, it represents the collective judgment of about fifty of the leading research specialists and college teachers in insect physiology, toxicology, ecology, applied entomology, anatomy, taxonomy, insect pathology, biological control of insects, insects as vectors of plant diseases, and medical entomology and parasitology. The committee wishes it understood that it is not offering that which follows as its mature and final judgment, but as a compilation of the various suggestions that have come to it. The committee also wishes here to express its appreciation to these men for their cooperation in this progress report.

Digest of Reports

The first quality to be considered in the training of a man, that of personality, is something no college training can give. The contacts of the student in college may knock off some of the rough corners, but the qualities most necessary are probably in the genes and are not subject to the external influences to which he is exposed. Interest and enthusiasm for his work form vital parts of personality. No student should be encouraged to go into the field of entomology who has not a keen interest in the subject and the ambition and ability to be successful and happy in it.

Entomology is not a unified field but includes a range of subjects, anyone of which may appear in the curriculum as a complete course. Since no text-book or series of publications attempts to cover the entire field, the student must turn to many sources for his information. He should be encouraged to read the current literature and to browse among the books and periodicals in the library stacks so that he may form during his college days a habit which will prove in later years not only a constructive recreation but also a great benefit. Particularly he should know where and how to look for information and above all, he should be able to interpret it, to judge its value, to correlate it and then to use it in an intelligent and purposeful fashion.

The two problems, training of undergraduates and graduates in entomology, seem to demand that the student should be well grounded in the fundamental sciences and that there should not be a standardized course for either advanced undergraduates or graduates.

The needs of each individual should be considered partly on the basis of interests, capacities and the educational achievement which the student already has attained, and partly on the basis of the field in which he expects to major. Educational standards should not be lowered to meet a sub-professional class. Positions in applied entomology that do not require graduate training should nevertheless be filled largely by those who complete the full four-year course, but who by preference seek to follow a less technical type of work. In the end these men will be broadened, better balanced and benefited by having acquired a reasonable amount of a liberal education and mastered some of the factual information needed in their chosen field.

There is something in the atmosphere of a graduate school with its advanced training, seminars, and frequent interchange of ideas among graduate students and faculty which cannot be gained elsewhere. From this atmosphere a student should acquire a knowledge of methods and technique, a maturity of judgment, and a philosophical view-point. A familiarity with experimental methods should be gained from these contacts, thus developing in the student the ability and desire to do high grade original work at the completion of his graduate years. Such training will permit him to keep pace with the advance of entomology in the years immediately ahead and above all inculcate the spirit and methods of the leaders in biological sciences.

The number of credits and sequence of subjects cannot always be fixed to meet local conditions in different institutions. Therefore, the summary of the questionnaires as given below does not contain the exact number of credits or the sequence in which the subjects are to be taken during the college years. In addition, it will not be amiss to state that physical education and military sciences are at present required at many of the institutions of higher learning, usually during the freshman and sophomore years.

Social Sciences and Humanities

Linguistic Sciences: Courses in English (including composition, literature, public speaking, and journalism) for at least two full years or a little longer were in nearly all cases recommended for the undergraduate major. The student should be able to evaluate and to organize his data correctly and to express his findings clearly in both the spoken and written word. Otherwise stated, the student should be thoroughly prepared and grounded in fundamental English and be able to use it fluently, accurately and forcefully.

Since it is utterly impossible to conduct research work in entomology or any other biological science without reviewing the literature in foreign languages, it was considered essential that a student should have a reading knowledge of both German and French. In view of the fact that many papers in certain specialized fields have been written in Italian, a reading knowledge of this language in some cases is highly desirable. Several of the men submitting reports recommended in special cases that the student be permitted to substitute either Italian or Spanish for French, but not for German. It should be noted here that there was a strong tendency to adhere strictly to the requirement of a reading knowledge of two foreign languages. This knowledge should be gained by the student in high school and college, if possible, before he completes his undergraduate studies. It should also be noted that a few of the workers felt that a reading knowledge of Latin was very desirable and, in fact, absolutely essential in certain fields. Several workers recommended that a knowledge of Latin should be acquired either in the high school or taken in the undergraduate years. One specialist stated that, in addition to a reading knowledge of Latin,

French and German, he would require students to have a reading knowledge of Russian and Norwegian.

SOCIAL SCIENCES: Training in the social sciences should be adequate to supply the cultural basis expected of the college trained man, yet flexible enough to fit his individual bent. Courses in history, political science, and economics as required work met with almost unanimous approval. Several men also recommended that the undergraduate student, if so inclined, should be given ample opportunity to elect courses in sociology, psychology, and philosophy. Students planning to follow teaching as a career should take courses in psychology of learning, principles of college teaching, and work under the guidance of a successful teacher in his chosen field before accepting a major teaching position. The ultimate capacity of a teacher is to render maximum value to society and to train and inspire leaders.

PHYSICAL SCIENCES

MATHEMATICS: One year or more of mathematics, consisting of college algebra, trigonometry and analytical geometry met with general favor in the questionnaires. A large majority also considered biometry to be essential. Those submitting outlines on insect physiology, insect toxicology and ecology also stated that calculus was an essential tool in these fields.

CHEMISTRY: From nearly two to four years of chemistry was recommended for the undergraduate student. Special emphasis was placed upon this subject by the men who submitted outlines in insect toxicology and insect physiology. General inorganic, organic and physiological chemistry were considered essential for the major undergraduate student. Qualitative analysis and quantitative analysis were advised by some, with not all the entomologists reporting. Bio-physical, physical and colloidal chemistry were among the subjects recommended as a minor for the student majoring in insect toxicology and insect physiology. As the course work in chemistry bears heavily on an already crowded program, demands have arisen for courses in chemistry which place the major emphasis upon biological rather than industrial phases. For instance, certain institutions are already offering courses in inorganic, organic and physical chemistry in which the chemistry of protoplasm and of life processes rather than that of iron, steel and dye stuffs is stressed.

PHYSICS: A course in general physics (one year) was unanimously advocated. In both insect physiology and insect toxicology an additional course in advanced physics was considered very desirable. In special instances, such as when the thesis problem involves a study of the effect of light upon the behavior of insects, physics might be taken as a minor subject in the graduate work.

GEOLOGY: A general course in geology met with favor as an undergraduate subject. Paleontology should be recommended in certain phases of entomology. Meteorology was also mentioned by several of the specialists.

BIOLOGICAL SCIENCES

There was a general feeling that the scientific training of the undergraduate student should give him an elementary and yet a sound fundamental training in the biological and related sciences as a foundation for future specialization in entomology. Beyond the foundation work in general zoology, physiology, entomology, apiculture, bacteriology, botany, and plant pathology there was not very much uniformity in the reports, especially in the recommendations for the senior college and graduate years.

BOTANY: A course in general botany was specified by practically all the men returning questionnaires. Bacteriology, plant pathology, and some systematic botany were also considered highly desirable. Graduate work in botany, ecology, plant pathology, morphology, or physiology were mentioned as desirable minors for certain types of entomological work.

ZOOLOGY: Courses in general zoology (invertebrate and vertebrate), animal microtechnique, parasitology, elementary entomology, applied entomology, apiculture, anatomy of insects, systematic entomology, embryology, genetics and general physiology, were recommended by a very large percentage of the men submitting reports. In case general physiology is not offered, it was strongly recommended that the student be required to take a course in human physiology. Insect physiology should be taken either as an advanced undergraduate or graduate subject. In institutions where no work is offered in insect physiology, it was suggested that required reading should be outlined and assigned to the student. In certain fields taxonomic and applied zoology as well as anatomy and histology were considered desirable. Students majoring in medical entomology and parasitology could use to their advantage training in protozoology, animal pathology, helminthology, immunology, serology and special courses in animal husbandry. In other special fields, survey courses in horticulture, farm crops, forestry and agriculture are desirable. Workers preparing to specialize in the study of insects as vectors or carriers of plant diseases should put a considerable amount of time on botany (morphology, physiology, taxonomy and bacteriology) and its applied fields in agriculture. It was also recommended that students should do field work during the summer period to gain experience in the practice of applied entomology. In the advanced undergraduate or senior college, and especially in the graduate college, there is no absolute standard which will apply to all fields of entomology. To illustrate, pharmacology was strongly recommended for either the undergraduate or graduate student majoring in insect physiology and insect toxicology. However, advanced and graduate courses in zoology, entomology and physiology were unanimously recommended by all who submitted reports.

The dissertation (thesis) should embody the results of independent research work in some field of entomology, written with consideration of existing literature. A thesis may or may not be required for a master's degree, depending upon the institution. If required, it may represent some phase of a problem to be carried on towards a doctorate dissertation or an entirely separate problem within the limits of organized study required for this degree. The doctorate thesis should represent a more comprehensive contribution to knowledge.

Special effort should be made to permit the student in both undergraduate and graduate years to progress in his chosen field as rapidly as his educational development and physical and mental capacities will permit. Especially should the spirit of independent research skill, and resourcefulness be initiated and fostered early in the capable and superior student, and at the same time keeping in mind that no two intelligent beings can quite do equally well the same task in exactly the same time. Training in the humanities, social sciences, physical sciences and biological sciences should be reasonably liberal, well balanced and completed largely during the undergraduate and early graduate years.

Flexibility is the chief characteristic of a well balanced undergraduate training for a student planning to follow entomology as a career. The well trained entomologist should have enough liberal education to be tolerant towards his coworkers and ac-

ceptable to society as a whole. The curriculum should emphasize the articulation of knowledge as a unit rather than the acquisition of fragmentary bits of knowledge. Several workers stated that as a rule a well balanced and liberal training adapted to the individual tastes, talent and personality of the student can be better obtained in the college of liberal arts and sciences than in the college of agriculture, unless agriculture exempts major students in entomology from a large percentage of the required courses. Under the latter arrangement it is highly desirable for students in certain fields of entomology to come up through agriculture and thus gain a general knowledge of the principles of agriculture.

So far as possible the student, particularly the graduate, should be encouraged to visit and study the research methods of the larger federal, state and college laboratories. He should also be encouraged to join, support, attend and take active part in the local, state and national societies in his chosen field. For the students of today will be the leaders in entomology of tomorrow.

In conclusion it must be stated that neither institution, equipment, facilities, nor instructor can train and educate the student. At most they merely offer the opportunities and it is for the student himself to secure his education.

The committee recommends that the committee be continued.

(Signed) W. A. RILEY
W. C. O'KANE
H. J. QUAYLE
A. C. BAKER
C. J. DRAKE, *Chairman*

Voted, that the report be adopted and the Committee continued.

PRESIDENT FRANKLIN SHERMAN: We will now listen to the Report of the sub-committee on Entomological Exhibits for the Chicago Century of Progress Exposition.

REPORT OF THE COMMITTEE ON ENTOMOLOGICAL EXHIBITS FOR THE CHICAGO CENTURY OF PROGRESS EXPOSITION

The committee held three meetings during the past year, one at the time of the Des Moines Meeting of the American Association of Economic Entomologists, one at the time of the North Central States Entomologists' Meetings at Lafayette, Indiana, Mar. 6, 1930, and one at the time of the Cleveland meeting of the American Association of Economic Entomologists, Dec. 29, 1930.

There have been some changes in the personnel of the committee, Professor T. J. Headlee having withdrawn from the committee and Professors Essig, Spuler and Houser having been added to the committee. Professor Essig is assisting Professor McLaine in the planning of the unit on "Introduced Pests" and he, with Professor Spuler, are in charge of the unit on "Insect Pests of Growing Fruits, including deciduous and citrus fruits." Professor Houser is working with Professor McLaine in planning the unit on "Shade and Forest Insects." Plans more or less detailed for sixteen units for the entomological exhibit have been submitted to the Fair Management.

During the past year all of the science sub-committees have submitted their plans for exhibits to the Fair Management and these have been considered in detail. Recently, active work was started in assembling and erecting the exhibits. In order

to carry out the exhibit as planned, it will be absolutely necessary to have the full co-operation and help of entomologists from all parts of the country, and it is hoped that everyone will aid in making this exhibit a real credit to the science of entomology. The exhibit as now planned will consist of the following units with members of the committee planning the units indicated:

No.	Title of Exhibit	Planned by
1	Introduced Pests	Prof. L. S. McLaine Professor E. O. Essig
2	Spraying, Dusting, Fumigating, Insecticides, Appliances and Equipment	Prof. T. H. Parks
3	The Value of Insects to Man	Dr. E. F. Phillips Dr. F. E. Lutz
4	Mass, Number and Kinds of Insects as Compared with Other Animals	W. P. Flint
5	Biological Control of Insects	Prof. G. A. Dean Dr. W. H. Larrimer
6	How Insects Live	Dr. C. L. Metcalf
7	Insects as Carriers of Plant Diseases	Prof. T. H. Parks Dr. F. E. Lutz
8	Insects Annoying to and Carrying Diseases to Man and Other Animals	Dr. F. C. Bishopp
9	Insects injurious to field crops (with the grasshopper as a typical example)	Dr. W. H. Larrimer
10	Insects attacking cotton (with the cotton boll weevil as a typical example)	Dr. W. E. Hinds
11	Insects as Pests of Growing Fruits (with the codling moth and some citrus insect as typical examples)	Prof. E. O. Essig Prof. Anthony Spuler
12	Amount and Kinds of Taxes Collected by Insects	Prof. J. J. Davis
13	Household insects (including carpet beetles, bedbugs, termites and clothes moths as typical examples)	Dr. C. L. Metcalf W. P. Flint
14	Stored grain insects (showing bran bugs, grain moths and grain beetles as typical examples)	Prof. G. A. Dean
15	Ants and Aphids	Prof. J. J. Davis
16	Shade Tree and Forest Insects (with the gipsy moth and bark beetles as typical examples)	Prof. J. S. Houser Prof. L. S. McLaine

W. P. FLINT, *Chairman*

Voted, that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: I will now appoint the following committees:

Committee on Resolutions: W. P. Flint, Arthur Gibson and R. W. Harned.

Committee on Nominations: W. E. Britton P. J. Parrott and A. G. Ruggles.

Committee to Consider a Proposal made by the Genetics Section of the American Association for the Advancement of Science, relative to Forming a large Biological Society: Glen W. Herrick, E. A. Back and D. M. De Long.

Elector to the National Research Council: H. E. Hodgkiss.

Secretary A. F. Burgess read a telegram received from O. I. Snapp, Secretary of the Cotton States Branch, conveying the greetings of the

Branch and inviting the members to attend the annual Branch Meeting which will be held in Atlanta, February 5–6, 1931. He also called attention to the severe illness of Mr. Thomas H. Jones, who served as Secretary protem at the Annual Meeting last year. It was voted that a telegram of sympathy be sent by the Association to Mr. Jones, who is now in a hospital in Boston.

Mr. W. E. Hinds stated that the next annual meeting of the Association will be held in New Orleans and suggested that the Cotton States Branch would probably act on a proposal that the Association and Branch meeting be merged next year. No formal action was taken by the Association, but it was the concensus of opinion that this should be done, if agreeable to the Cotton States Branch.

Mr. W. C. O'Kane stated that the American Association for the Advancement of Science would hold a summer meeting next June in Pasadena, Cal. and suggested the possibility that it might be desirable to hold a summer meeting of the Association at that time, which would be merged with the meeting of the Pacific Slope Branch. It was voted that the Executive Committee take under consideration the calling of a special summer meeting at Pasadena next June.

REPORT OF COMMITTEE OF AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS ON CERTAIN PROPOSED AMENDMENTS TO THE INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE[1]

It is the opinion of this committee that the primary nomenclatorial interest of the entomologists who form the membership of the American Association of Economic Entomologists lies in the permanent stabilization of the technical names applied to all insects, whether pests or not. It is the view of the Committee that any suggestions of changes in the International Code which will weaken or retard the effort to secure the permanent fixation of scientific names applied to insects should be combated vigorously. The International Code, as it now reads, appears to contain the broad rules for nomenclatorial procedure necessary to the ultimate solution of the major problems arising from the application of nomenclature to zoology. In view of this the Committee believes that any further changes in the Code should be made only after the fullest possible discussion of the desirability of the same. Regarding the detailed proposals for change published by Dr. Stiles in Entomological News, vol. 40, December 1929, the Committee's opinions are as follows:

1930A. Since the Commission's authority and responsibility in passing judgment on proposals for changes in the International Code would undoubtedly be weakened if a majority vote only in the Commission and in the Congress itself was accepted as adequate authority for changes, this Committee is strongly adverse on the proposal for acceptance of majority vote both in the Commission and in the Congress.

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[1]This report was approved by the Executive Committee and ordered printed for the information of the members.

1930B. While it is undesirable that a single member should be able completely to block modifications in the Code which are strongly approved by all other members, this Committee is opposed to any changes in procedure that would result in weakening the position of the Commission as the responsible arbiter of the Rules of Nomenclature. If past experience has shown that such blocking can occur, an attempt should be made to prevent this, but under such conditions this Committee believes that two adverse opinions, either in the preliminary vote by the full Commission or at the formal meeting of the Commission preceding the Congress, should be sufficient to prevent the approval of proposed changes.

1930D. In general, type designation appears to be proceeding satisfactorily on the basis of the present rules and this Committee therefore opposes the elevation of the elimination recommendation to the status of a rule.

1930E. The Committee is likewise definitely opposed to the elevation to the status of rules of the recommendations cited.

1930F. Since this proposal has been consistently rejected for nearly 30 years, its status should be considered as definitely settled.

1930G. The 10th edition of Linnaeus' Systema naturae has been accepted for so many years as a starting point for systematic zoology that no change should be made at this date.

1930H. This proposal contains so many elements that it can hardly be passed on as a whole without detailed study. Some improvement from a nomenclatorial point of view respecting the standards of publication is unquestionably desirable, but further analysis and discussion of this proposal as it stands would seem to be advantageous before a final decision is arrived at by the Commission.

1930I. In the opinion of the Committee, this proposal is one which should be accepted by the Commission and the Congress as are those quoted under 1930J.

The changes in the language and other features of the International Code of Zoological Nomenclature which would result from the adoption or substitution of any or all of the propositions contained in proposals 1930K, 1930L, 1930M and 1930N are so great that it is definitely undesirable to consider adoption of any of them *in toto.*

C. F. W. MUESEBECK
CARL J. DRAKE
HAROLD MORRISON, *Chairman*

At the close of the Thursday morning session Mr. O. A. Johannsen read a letter from Dr. K. Jordan, Permanent Secretary of the International Congress of Entomology relative to the next meeting of the Congress in Paris in 1932, and urged that a large number of the members of the Association attend this Congress. He stated that steamship rates had been reduced and that living expenses were considerably less in Paris than in the United States. Large delegations are expected from England and continental Europe, and American entomologists should be well represented.

At the close of the afternoon session Thursday, Mr. William E. Hoffmann, a member of this Association who has spent the last six and one-half years in China, was introduced. He stated that he had attended

the Fourth Pan Pacific Science Congress which was held in Java in 1929, and the Eleventh International Congress of Zoology held in Padua, Italy last September. At the conference held in Java a standing committee on Pacific Economic Entomology was appointed, the idea being for this Committee to interest their respective governments in financing one or two specialists to be stationed at well established institutions for the purpose of working on parasitic Hymenoptera and Diptera of economic importance in their particular region, so that beneficial species might be more generally known and accurately determined in the Pacific area, particularly in oriental countries. At this conference several very good contributions were made toward a survey of the rice insects of the world. The details concerning this matter will be printed in the Lingnan Science Journal published in China.

The Proceedings of the International Congress of Zoology will contain a number of entomological papers and will soon be published. Professor Hoffmann expressed his great pleasure in having an opportunity to attend the meeting and renew entomological acquaintances in the United States.

FINAL BUSINESS SESSION

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Committee on Resolutions. The Resolutions Committee will present its report in two items, covering general resolutions and a resolution relative to the Mediterranean Fruit Fly.

REPORT OF COMMITTEE ON RESOLUTIONS

Your committee submits the following resolutions:

1. *Resolved*, That the thanks of the members of the American Association of Economic Entomologists be given to the Cleveland Chamber of Commerce, the Trustees of the Western Reserve University and the Case School of Applied Sciences for providing the excellent arrangements for the meetings.

2. *Resolved*, That the thanks of the members of the American Association of Economic Entomologists be given to the Trustees of the Cleveland Museum of Natural History for the opportunity given the entomologists to meet other biologists at the reception given by the Museum.

3. *Resolved*, That the thanks of the members of the American Association of Economic Entomologists be given to Mr. J. C. Pallister, Entomologist of the Cleveland Museum of Natural History, for his efforts in making the arrangements for the entomologists banquet.

ARTHUR GIBSON
R. W. HARNED
W. P. FLINT
Committee

MEDITERRANEAN FRUIT FLY RESOLUTION

WHEREAS, The establishment of the Mediterranean Fruit Fly in Florida constituted a great menace to the horticultural industries of the south and west and,

WHEREAS, The campaign to eradicate this pest has accomplished results far beyond our expectations, and

WHEREAS, This campaign is one of the outstanding achievements in the annals of economic entomology.

BE IT THEREFORE RESOLVED, That the American Association of Economic Entomologists here assembled extends to the Plant Quarantine and Control Administration of the United States Department of Agriculture and to the State Plant Board of Florida its congratulations on the great work accomplished to date.

AND BE IT FURTHER RESOLVED, That a copy of this resolution be forwarded to the President of the United States, the Secretary of Agriculture, the Governor of Florida, and to the officials of organizations involved.

ARTHUR GIBSON
R. W. HARNED
W. P. FLINT
Committee

After minor changes in wording the report of the Committee was accepted and the resolutions adopted.

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

Your committee has the pleasure of submitting for your approval the following report of its activities for the year.

(1) In view of the long and distinguished services of Dr. L. O. Howard the committee recommends that all dues be remitted.

The committee also recommends the remission of the dues of George G. Atwood of Albany, New York.

(2) The committee recommends that Chukichi Harukawa, of Ohara Institute for Agricultural Research, of Kurashiki, Japan, be elected to Foreign Membership.

(3) The committee recommends that the following six (6) candidates be reinstated as Associate members:

John W. Bailey	W. W. Henderson
Ashley C. Browne	W. B. Mabee
E. K. Bynum	E. Graywood Smyth

In this we have followed the precedent established by recent membership committees.

(4) The committee recommends that the following thirty-three (33) Associate members be advanced from Associate to Active membership.

W. A. Baker	J. C. Gaines	H. K. Riley
F. F. Bibby	R. C. Gaines	R. H. Robinson
M. V. Boyd	H. C. Hallock	R. F. Sazama
Stanley W. Bromley	G. E. R. Hervey	H. D. Smith
L. R. Cagle	J. L. Hoener	C. J. Sorenson
P. J. Chapman	W. N. Keenan	F. J. Spruijt
C. E. Cooley	A. A. Mathewson	M. C. Tanquary
E. C. Cotton	R. R. McLean	Neely Turner
Howard Deay	C. B. Nickels	H. H. Walkden
George C. Decker	W. L. Owen, Jr.	H. G. Walker
K. P. Ewing	J. B. Parker	H. E. Whitehead

(5) The committee recommends that the following ninety-six candidates be elected to Associate membership:

T. L. Aamodt
M. V. Anthony
Kenneth A. Bartlett
W. Delles Bedard
Samuel C. Billings
Erle G. Brewer
Wm. T. Brigham
G. C. Broome, Jr.
A. E. Brower
Ross W. Brubaker
Dwight Buchanan
Stanley J. Carpenter
H. K. Clifton
James F. Cooper
James A. Cox
A. W. Crawford
D. J. Crowley
Emory C. Cushing
Ralph H. Davidson
Louis G. Davis
Ralph W. Dean
J. Don De Coursey
Charles Denny
Kenneth Dorward
Wm. J. Douglass
Lonnie C. Elmore
Charles O. Esselbaugh
John H. Evans
Ray T. Everly
Lowell J. Farmer
Robert H. Fox
George W. Garretson
George H. Geissler
Claude C. Gillette
C. M. Gjullin
Charles B. Gnadinger
Newell E. Good
F. W. Gregory
Cecil R. Gross
Roy A. Grout
Charles C. Gwinner
Louise E. Haas
Wm. R. Haden
Frieda B. Hinnenkamp
P. A. Hoidale
W. D. Hollingsworth
Don W. Hookum
F. G. Hopkins
George Horton
Harmon R. Johnston
Howard A. Jones
Victor E. Jones
Fred W. Kegley
Sam G. Kelly
Virgil F. Kent
Edward F. Knipling
Birely J. Landis
Carol D. Lebert
David L. Lindgren
Erskine M. Livingstone
Earl W. Longan
G. F. Manson
L. Chester Marston, Jr.
James M. McGough
A. Gordon McNally
James M. Merritt
D. C. Moody
Warren Moore
Luis M. Murillo
John H. Myers
R. I. Nel
R. H. Nelson
Wm. Carl Nettles
Lawrence B. Parker
Harold C. Pegler
Bailey B. Pepper
T. W. Reed
Paul L. Rice
H. K. Rippey
C. B. Roark
Archie R. Rolfs
R. W. Salt
Ernesto Sanchez
Fenner S. Stickney
Thomas P. Strand
Friar M. Thompson, Jr.
Robert Wm. Thompson
Bernard Travis
Mathew A. Vogel
H. A. Waters
Russell R. Whitten
Orville L. Williams
Paul A. Woke
A. M. Woodside
E. E. Zeisert

(6) The committee recommends that the resignations of the following members be accepted:

Active:

Otis Wade

Associate:

H. C. Atwell
M. L. Dean
C. W. Drury
James N. Farley
Karl W. Johnson
A. J. Spangler
W. H. R. Werner
G. E. Woodhams

(7) The committee recommends the present policy of requiring the payment of the current year dues from members desiring to resign, be discontinued. We recommend that the following policy be adopted, namely that the Secretary and acting membership committee be authorized to accept as effective at once all resignations received, provided that all past dues outstanding are paid and any copies of the current year JOURNAL that may have been sent to such resigning member are paid for at the single copy price. Such policy will avoid misunderstandings that have arisen in the past and will relieve the Secretary of considerable unnecessary correspondence.

Signed

HARRY F. DIETZ, *Chairman*
S. W. BILSING

Voted, that the report be adopted.

SECRETARY A. F. BURGESS: Mr. E. Graywood Smyth having paid the required fee, now becomes a Life Member of this Association.

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Advisory Committee covering nomination of officers for the JOURNAL OF ECONOMIC ENTOMOLOGY.

MR. W. H. LARRIMER: A letter has been received from Mr. C. W. Collins indicating that he does not wish to continue as Business Manager of the JOUHNAL OF ECONOMIC ENTOMOLOGY. The Committee therefore reports the following nominations. Editor, E. P. Felt, Associate Editor, D. M. DeLong, Business Manager, A. F. Burgess.

Voted that the report be adopted.

PRESIDENT FRANKLIN SHERMAN: We will now hear the report of the Committee on Nominations.

REPORT OF COMMITTEE ON NOMINATIONS

President: J. S. Houser, Wooster, Ohio.

First Vice-President: W. E. Hinds, Baton Rouge, La.

Vice-Presidents: (Pacific Slope Branch)—R. E. Campbell, Alhambra, Calif.
(Eastern Branch)—W. J. Schoene, Blacksburg, Va.
(Section of Plant Quarantine and Inspection)—K. C. Sullivan, Jefferson City, Mo.
(Section of Apiculture)—S. W. Bilsing, College Station, Texas.

Executive Committee for 3 years:
W. P. Flint, Urbana, Ill.

Membership Committee for 3 years:
W. H. Larrimer, Washington, D. C.

Advisory Board, JOURNAL OF ECONOMIC ENTOMOLOGY:
G. M. Bentley, Knoxville, Tenn.
L. A. Stearns, Newark, Delaware

Committee on Endowment:
V. I. Safro, West Nyack, N. Y.

Committee on National Museum:
J. J. Davis, Lafayette, Ind.

Committee on Research Work on Control of the European Corn Borer, 3 years:
J. J. Davis, Lafayette, Ind.

Board of Trustees for Permanent Fund:
C. L. Marlatt, Washington, D. C.

Alternate Representative to National Research Council:
J. E. Graf, Washington, D. C.

Councillors for the American Association for the Advancement of Science:
W. E. Hinds, Baton Rouge, La. M. H. Swenk, Lincoln, Nebraska

Trustees for Crop Protection Institute:
W. P. Flint, Urbana, Ill.

Representatives on Council of Union of American Biological Societies:
A. L. Quaintance, Washington, D. C. C. R. Crosby, Ithaca, N. Y.
Committee on Investigations on Codling Moth:
G. A. Dean, Manhattan, Kansas Leroy Childs, Hood River, Oregon

Respectfully submitted,
W. E. BRITTON
P. J. PARROTT
A. G. RUGGLES
Committee

Voted, that the report be accepted and that the Secretary be instructed to cast one ballot for the officers named. The ballot was cast and they were declared elected.

PRESIDENT FRANKLIN SHERMAN requested past presidents Gibson and Felt to escort President elect Houser to the chair and after congratulating him on his election, turned the meeting over to him as presiding officer.

PRESIDENT ELECT HOUSER: I want to thank you, President Sherman for the very kind remarks that you have made. I have always been a man of few words in my connection with this Association. I am not going to break that precedent at this time by attempting to make a speech. The only thing I wish to say is that I am committing myself to the welfare of this Association. Mr. P. J. Parrott congratulated President Houser and asked that a vote of thanks be extended to President Sherman for the efficient manner in which he had handled the meeting. This motion was unanimously approved.

PRESIDENT J. S. HOUSER: Is there any miscellaneous business? Mr. W. E. Hinds, as representative of this Association on the Council of the American Association for the Advancement of Science, called attention to the summer meeting of that Association at Los Angeles and Pasadena next June and stated that it was not the intention that this should be a regional meeting but a national meeting with affiliated societies participating. It was hoped that a large number of members would attend this meeting. A considerable number of members indicated their opinion that the Association should hold a meeting next summer. Mr. W. C. O'Kane stated that the Pacific Slope Branch would undoubtedly hold their meeting at that time and there was a possibility that the National Plant Board might also meet there. He expressed doubt as to whether a large number of members, in addition to those belonging to the Pacific Slope Branch, would be able to attend if a special meeting of the Association was called. Mr. H. J. Quayle stated that the Pacific Slope Branch would meet as usual with the Pacific Slope Branch of the American Association for the Advancement of Science in June, and if it seemed

inadvisable for the parent Association to hold a meeting, the Pacific Slope Branch would welcome all entomologists who could attend.

Mr. E. P. Felt offered a motion that a vote of thanks and appreciation be extended to Mr. C. W. Collins for the work which he had done for this Association and the JOURNAL OF ECONOMIC ENTOMOLOGY. The motion was passed unanimously.

Mr. W. C. O'Kane discussed the matter of arranging the program at the annual meetings along the line of dividing the subject matter into two types for presentation, one by abstract of 300 words on the part of any who wished to present material, and the other by invitational papers, representing more substantial and important contributions to occupy a longer time.

Attention was called by the Secretary to the recommendation of the Executive Committee that the President arrange for a special speaker to occupy one morning session at the next annual meeting. Mr. O'Kane stated that he was in sympathy with that arrangement, but believed that a special committee should be appointed by the President to arrange the program along the lines which he suggested in order that the plan might be tried at the next meeting.

Mr. W. P. Flint asked if the presentation of abstracts would permit the use of one or two lantern slides which might summarize the subject matter. Mr. O'Kane stated that it could be done that way and the Association could indulge in all the discussion which was necessary for a period which might occupy even five, ten or fifteen minutes, and that the abstracts as far as possible should be printed before the time of the meeting. Mr. T. J. Headlee asked if this plan had not been tried by the Pathologists and modified in favor of sections. This question was not answered satisfactorily. Mr. E. P. Felt stated that he very much doubted whether anyone could arrange a program that would be satisfactory to all, but would like to see something along this line tried. He felt that the papers presented at the meeting had not been allowed time enough either for presentation or discussion, but did not believe that the members would like to stay at the meeting for more than three days.

Mr. Granovsky stated that a number of societies divide their programs into several sections which run simultaneously and suggested that one or two general sessions pertaining to general fields of entomology be held, at which time invitational or more important papers could be presented, and that shorter papers running between five to fifteen minutes could be handled in sections running simultaneously. He doubted whether a subject could be discussed very much in 300 words, but that the publication of abstracts was very desirable. Mr. H. J. Quayle felt that the pro-

grams were not satisfactory and believed more time ought to be available for discussion. He did not feel that a committee should be definitely committed to any particular policy, but after due consultation should work out a plan which seemed to be most feasible. He favored sectional meetings, devoting mornings to meetings having papers of general interest, and the afternoons to sectional meetings where matters of narrower scope could be presented.

Mr. W. C. O'Kane stated that in the arrangement of the program we cannot meet all the demands that will be made, but that the Committee should include the suggestions offered relative to general programs and sections.

Mr. W. E. Hinds remarked that in looking over the program of the Entomological Society of America a considerable number of papers were of economic interest. The program this year had covered two solid days, and if papers of economic interest before the other Society were to be heard by the members, three days would have been required.

Mr. V. I. Safro thought that many of the papers that were read at the Association meetings would really be of more interest at branch meetings where a greater amount of time was available. He stated that he had attended a number of branch meetings and there was more discussion than at the national meeting.

Mr. T. J. Headlee favored the sectional idea of arranging the program, as it gives the individual members of the Association an opportunity to present a paper on account of his membership in the Society. He believed it was the only plan that did not transgress the rights of the individual as set forth in the Constitution of the Society, and that the scheme would work, although a different arrangement for rooms would be necessary. He indicated that he was very much opposed to abrogating the right of the individual to present a paper if he wished to do so and felt that this right was the life of the Association.

On motion, duly seconded, it was voted that the President appoint a special committee to provide for programming the next meeting.

It was voted that the President appoint a committee of two to work in connection with a similar committee of the Entomological Society of America to look into the facilities and accommodations that can be secured in connection with the attendance at the International Congress of Entomologists to be held in Paris in 1932 and report at the next annual meeting.

Voted, that the time and place of the next annual meeting be referred to the Executive Committee, with power to act.

There being no further business, the meeting adjourned at 4:30 p. m.

PART II. ADDRESSES, PAPERS AND DISCUSSIONS

The session for presentation of technical papers convened immediately following the business session of Wednesday morning, December 31, with Vice-President J. S. Houser in the Chair.

VICE-PRESIDENT J. S. HOUSER: We will now hear the annual address of the President, Franklin Sherman.

CENSUS TAKING IN ENTOMOLOGY

By FRANKLIN SHERMAN, *President American Association of Economic Entomologists*

ABSTRACT

Studies of the insect fauna may throw light upon zones of distribution and destructiveness of insect pests; may give information on minor pests which have not been much studied, and on insects now unnoticed which may later become pests. In a relatively new country like ours, native insects may yet be expected to become destructive. Introduced pests are already numerous and destructive. Materials and data accumulated in faunistic studies are of value in teaching.

For a presidential address the speaker may choose a subject which has long held a place in his thoughts or to which he may have given an appreciable share of his efforts,—but according to the traditions of this Association he must present an address of some sort. The past, present and probable future trends and methods in research; trends in the entomological profession itself, and many other topics important in economic entomology have been well discussed in past presidential addresses and in many other papers by persons far more competent to discuss them than is your present speaker.

Nineteen-thirty has been an official census year, so it may be in keeping with the times to consider the state of our knowledge of our entire insect population, natives and immigrants, injurious and beneficial, those neutral and those whose relations to human welfare are not now known, and there are many of these,—for our federal census gathers much comparable data on our human population, beyond the numerical count.

It is not claimed that a study of our entire insect fauna is an immediate, pressing, imperative necessity of the day. No delegations are clamoring at the doors of our legislative halls demanding appropriations for the purpose. Rather we may regard it as supplying a background or basis from which we may start in many lines of entomological inquiry.

It is immediately to be acknowledged that studies upon our insect fauna are also within the scope of our younger sister organization, the

Entomological Society of America. The close coördination of interests and effort between these two organizations is evident from the fact that a large proportion of the members belong to both. It would thus appear that there would be abundant opportunity for coordination of effort among those who might be interested.

As corner-stones upon which to base the thesis of this paper four ideas are here presented:

1st. A greatly respected advisor, at the close of a discussion of some abtruse subject, remarked: *"All truth is of value."*

2nd. One of the speakers at our Entomologist's Supper in New York two years ago had this as his closing sentence: "Whatever phases of entomological science we may choose for specialization we must not forget that, first of all, *Entomology is the study of insects."*

3rd. Many of us here present heard one of our most respected members, in a written paper arguing for entomological studies even along lines which give no promise of immediate benefits, declare: *"All entomology is economic."*

4th. Ours is the American Association of Economic Entomologists. The adjective "economic" frequently occurs in our Constitution, yet in its declaration of objects we find under caption (4): *"To promote the study and advance the science of entomology,"* and at this point the adjective "economic" is omitted. It is as if in recognition that all entomological knowledge is or may become of economic worth."

And the main suggestion of this address is for the undertaking of studies which shall add to what we now know of our insect fauna in its entirety, to ascertain so far as possible the direction of the influence of every species, for at some future time that influence may become decidedly economic,—yet leaving the detailed study of important individual species for separate definite projects of research such as are already familiar to us.

Undoubtedly we do know which the most injurious insects in North America now are, although we may not be agreed as to which ranks first in destructiveness, which second, and so on through the list. But there yet remain many lesser pests which have not been adequately studied. Many such are but vaguely known, and perhaps some of them are not yet even described.

The writer's first independent work in entomology was in a state (North Carolina) in which there was no accumulation of insect records of any sort, and when the practice was adopted of using an outline map for each insect and marking upon it the localities from which complaints

originated, the records soon proved that certain pests were present, or were usually destructive, only within certain belts or zones,—oyster shell scale was destructive in the western part of the state but not in the east, while billbugs (*Sphenophorus* spp.) were destructive to corn in the east but not in the west. It was found that while chinch bug was actually present throughout the state, it was an important pest only—or chiefly—in the central portion of the state, confirming the distribution map of Professor F. M. Webster. Perhaps that sort of thing was already trite to those in states where entomological work had long been in progress, but its proving by records and experience was highly interesting and helpful to the then young entomologist.

At the same time some teaching was being done in which it was desired that students should know other insects besides those which damage crops,—ones which resembled the pests perhaps but were harmless. Thus developed the practice of collecting and securing identifications of all kinds of insects, plotting their ranges within the state, and recording seasonal data, often with brief notes on food, habits and life stages. In time the collections and records became a frequent source of reference, and investigators of certain groups or species often requested such records as could be supplied.

This practice has now been followed in South Carolina for a number of years, though not scheduled as a major project and it never occupies the greater portion of time over any considerable period. It is conducted as a helpful supplement to many phases of work. It even serves as an enjoyable recreation. Much of it can be done despite interruptions and delays, which is not true in most lines of investigation. Labelled specimens and records are reasonably permanent and may be studied and data compiled even years afterward.

At the last meeting of the Entomological Society of America there was a symposium on the "Contributions of Major Importance which North America has made to the Study of Insects," the printed report of which has come to hand as this paper is being prepared. In the six papers of that symposium the work of Canada and the United States in the advancement of entomology (both pure and applied) is so well set forth that we must feel gratified by the progress which has been made. In those papers are several allusions to zonal distribution; statements that certain pests seem to attain maximum destructiveness within certain zones in coincidence with certain soil types or other ecological factors; and suggestions that in certain cases (especially in dealing with forest insects) control measures may often be based upon the manipulation of ecological factors.

We are coming to understand that an insect which has habits inimical to our welfare becomes destructive where and when its natural rate of increase; i.e., its biotic potential, is able to outstrip those factors which limit its increase; i.e., the environmental resistance. This sounds like an explanation of our old friend Balance-of-Nature in ecological phraseology, and it challenges us to know, to analyze, and even to evaluate each and every one of the many factors which limit insect increase,—including all parasites and all predators, not only insects but also birds and other animals. And here we encounter our modern idea of "biological control" which is highly interesting to us at present, and in which many efforts are now being made in the endeavor to control a number of our destructive insects. If these several lines of study be followed to completion we shall need to deal with a very large part of our entire fauna, for we already appreciate that the Web-of-Life operates like a complex machine of numerous parts, and although it appears to us that all the parts are not of equal importance, yet we are far from the ability to evaluate each.

It may be found, if indeed it is not already established, that the zone within which an economic insect attains its maximum, may be indicated or confirmed by the distribution of other insects which may not be pests, or by the distribution of other animals,—mammals, birds, reptiles or others. Thus studies of our insect fauna may be all the more informing if similar data upon other animal groups is available. This suggests cooperation where possible, but if this is not to be had the entomologist will find abundant material for his labors within his own field.

A number of groups of decidedly economic species are but vaguely known to many of us. Comprehensive studies of such complexes as the cutworms, the sod webworms and a number of others have been made in only a few states, leaving us largely to inference as to which species may actually be present in any given region. It would thus appear that there is yet opportunity for much faunistic work of economic value in many sections of our continent.

Usually our projects of investigation have been limited to a few insects, often to only one insect of some one crop,—yet the ecological trend inclines to the inclusion of associated insects also,—or, the study of one insect may lead almost inevitably to another, thus embracing an ever increasing portion of the entire insect fauna of the crop. There seems to be room for much expansion in this way, for with reference

to the two chief crops of the southern states for example, it may be doubted whether a compilation from all the present literature would give a complete list of the insects which regularly attack the plants of cotton or of corn. Perhaps the lists change from time to time,—cotton flea hopper was not known as a pest of cotton until a few years ago. Perhaps there is a fitting place for studies upon the entire insect fauna of other crops, and even of wild plants. Now and again the Insect Pest Survey Bulletin of the Bureau of Entomology at Washington has recorded damage by insects not before ranked as pests. Such incidents indicate that we may discover new factors of decided economic importance in the unexplored parts of our broad field. They also indicate that our problems of economic research might often be aided by the data which faunistic and ecological work may furnish on the distribution and areas of greatest abundance of insects which are not now important economically,—such data sometimes derived from such exact census methods as the actual counting and recording of the numbers of each species per square yard, or other unit of calculation.

It is the practice of many entomologists to study insects by zoological groups, and he who thus undertakes a study of the genus Phyllophaga, or of the family Elateridae, or Crambidae, or Acrididae, or Aphididae, or any one of many other large groups, will likely find much that is of local significance or importance and may add to what is known of species already recognized as economic.

Such studies would surely enlarge our catalogue of economic species and the boundaries of our field would be extended. They would call for more taxonomic work than is done at present, whether within the several state organizations, or through the taxonomic unit at Washington, or through the helpful courtesy of the specialists outside of our agricultural organizations. Possibly it would be well if there were encouragement and opportunity for workers of such tastes in more of our state organizations.

North America is yet relatively new as regards length of time during which agriculture has been practiced, and with our older areas being more densely settled and with new areas being brought into cultivation with its displacement of many species of plants by only a few, it would seem inevitable that many native species of which we now take no notice will become noticeably destructive. This newness of our continent has affected our profession profoundly, for with the growth of commerce and the introduction of plant materials from abroad (now more

carefully guarded by the regulatory forces of both Canada and the United States) a large number of immigrant insect pests have come in to add to our census of insect pests and problems. A very large proportion of our work has to do with insects of foreign origin, and it has been largely as a result of our studies of these that our present interest in biological control has developed.

Yet as to our native species let us consider that about 20,000 species of Coleoptera are known in North America; that the Connecticut state list accounts for about 7,000 species of insects in that state; that the New Jersey list of 1910 shows more than 10,000 species, that the New York list shows about 15,000 species, and that in each of these states students are constantly adding to the numbers known. Each of these thousands of species is impelled toward an increase of its numbers. A hundred or two have succeeded in becoming too numerous for human comfort and these we promptly consider as "economic",—usually only these are deemed worthy of investigation. Is it not somewhat as if we were greatly concerned with the few heated drops which bubble out of a boiling pot, but were only indifferently concerned about the thousands of other drops in the pot itself? Might we not lift the lid and peep over the rim of the cauldron to see what is inside and what is going on there? How often in monographic papers such remarks as these are to be seen regarding species; "Food-plant unknown", or, "Life-history unknown." Verily, we are yet far from a complete knowledge of which species do and which do not affect our welfare. We are able as yet to give only incomplete census data in our chosen field of economic entomology. The suggestion is ventured that any plant-feeding insect is a potential liability, and that any predaceous or parasitic insect is a potential asset, and that as such all are within the pale of our consideration, at least to the extent of locating, recognizing and recording them. New Jersey, Connecticut and New York, all in the northeastern portion of the United States, are the only states which, to date, have published comprehensive lists of their insects.

* * * * * * * *

Many of us are charged not only with the duty of investigating economic insects, but also with the high duty of teaching our subject to students, some of whom are to fill and let us hope more than fill our own places; these students and their students in turn are to "carry on" after us. Perhaps the highest usefulness of faunistic work lies in its value in teaching, where its data, records and materials may be drawn

upon in opening the eyes, the minds, the conceptions, the imaginations and the understanding of the on-coming entomologists. It is suggested that the teacher may well emphasize to them (as no doubt is usually done) the great number of insects; the great diversity of their habits, "instincts" (an old-fashioned and expressive term) and life-histories; the play and counterplay of the natural forces which make for their increase or limitation, and the numerous adaptations and modifications of structure exhibited in the insect group. In this, the rich heritage of information which we have to pass on to them has come chiefly from the systematic entomologist, or from the old-time naturalist as we used to know him—his number seems to be fewer now. Those were the men who first won for our science a respectful tolerance. They studied insects because they loved the study of insects,—perhaps they believed that all truth is of value, and that all entomology is economic. While the student is being trained for the problems presented by the few hundred serious insect pests of the present, it might perhaps be well to remind him of the thousands of little-known insects which have not yet crowded themselves upon our notice, but which we surely know to be endowed with potentialities beyond our present knowledge. The materials resulting from faunistic studies are assuredly a help in this.

It is to be supposed that most of us were attracted to entomology because of our interest in insects,—not merely because of its financial remunerations, and perhaps not even because we considered it to be the most "economic" field open to us. Young men and women are still entering this profession because they, too, like to study insects. It is believed that those students with the most practical and economic tastes welcome the opportunity to get a glimpse beyond the group of important present-day pests. May they not be denied the privilege of seeing and experiencing what may be termed the fascination, the mystery, and the romance of the study of entomology.

Such studies of our insect fauna as are here suggested would greatly enrich the collections of insects in our colleges, museums and other institutions where entomological work is done. The young entomologist of the future would see with his own eyes actual specimens of thousands of species in our cabinets and could thus more keenly realize how much may yet be unknown. On the other hand the layman might thus be brought to a better appreciation of how much is known, and might be more inclined to accept professional judgment on entomological matters. Faunistic work has very great usefulness in teaching not only

students but also the general public. It is conceivable that it might add to what our profession has already won of both influence and dignity.

* * * * * * * *

Granted that we owe it to the public constantly to seek improvements upon present methods of control; granted that we should seek to handle adequately the insect emergencies that arise; granted that we should seek to improve the public welfare equivalent to and in excess of what the public expends upon us and our work,—the suggestion is humbly submitted that there is also an appropriate place for studies of insects which are yet almost or wholly unknown,—and for searching meadow and mountain, field and forest, earth and air and water, in the endeavor to reach some semblance of a balanced and complete knowledge of our entire insect fauna,—and of how each species in the entire assemblage affects us, whether for better or for worse, or whether for the present it appears to affect us not at all.

VICE-PRESIDENT J. S. HOUSER: Is there any discussion of the President's address?

MR. GLENN W. HERRICK: I should like to congratulate President Sherman on the address which he has given, and on the importance of the subject which he selected.

Some years ago I had occasion to desire knowledge concerning the distribution of some of the more common species of insects throughout the United Stated. I was astounded at the meagerness of the data on the distribution of some of the most common insects. It seems to me that this is a most important line in entomology and that it is not given the attention that it deserves. I am delighted that the President has discussed this matter and emphasized it in such an able way.

MR. W. E. BRITTON: I wish to compliment the President on the contents of his address and also on the able manner in which it was delivered. I believe that every person in the room heard and appreciated every word that he said.

MR. HERBERT OSBORN: I am glad that the President selected the subject that he did, and feel that he has indicated the method by which a great deal of valuable work can be done. It is the kind of work that can be done continuously, and in the course of time adds information which is of the greatest value.

VICE-PRESIDENT J. S. HOUSER: I should like to add to the sentiments already expressed concerning the excellence of this address. I think it

will go down in the records as one of the rather short presidential addresses, with the facts very clearly and concisely stated.

ADJOURNMENT: 12:30 P. M.

Wednesday Afternoon Session, December 31

The session convened at 1:45 P. M., President Franklin Sherman presiding.

PRESIDENT FRANKLIN SHERMAN: The afternoon session of the Association will now come to order.

The first item is a paper by E. N. Cory.

NOTES ON THE EUROPEAN HORNET[1]

By ERNEST N. CORY, *College Park, Maryland*

ABSTRACT

The European hornet, *Vespa crabro* var. *germana* Christ., seems to be on the increase in Maryland and is apparently extending its range to other states. Injures lilac stems and apples. Nests in hollows. Total population of one colony collected, 413 individuals.

The European Hornet, *Vespa crabo* var. *germana* Christ. has been known for several years in Maryland. It was determined by Miss Grace Sandhouse, U. S. National Museum, from specimens received from Elkton, Cecil County, in 1927. Since then specimens have been received from Cordova, McDaniel, and Easton in Talbot; Centerville in Queen Annes County; three locations in Baltimore County, Bengies, Whitemarsh, and Stemmers Run. The insect is known to be present in Connecticut, New York, New Jersey, Delaware, Maryland, and Illinois. Early accounts of the pest were given by the late J. B. Smith, E. P. Felt, and W. E. Britton.

The insect seems to have possibilities of becoming a serious pest. In Maryland the preferred woody plant seems to be the common lilac, which is gnawed and sometimes girdled. Stems ranging from pencil size up to stems nearly an inch in diameter are attacked. The insects congregate in groups of one to five on the gnawed surface and appear to feed greedily on the exuding sap. In captivity they fed readily on honey and fruit, but did not catch flies liberated in the cage. It is not uncommon to find a large number of stems wholly or partially girded on a single plant in the general neighborhood of a colony. In 1928 collections were made at Bengeis late in the season where injury to lilacs

[1]Contribution of the Entomology Department, University of Maryland.

had caused a correspondent to send in specimens of the injured shrub. A few miles further on at Whitemarsh similar injury was found. This area was not revisited until the fall of 1930 when insects were again found to be cutting the stems and lapping up the sap. Dr. E. A. Andrews of Johns Hopkins University reported the finding of a large colony at Stemmers Run in the same general area. From the size of the colony he reported it is probable that the specimens collected at Bengies and Whitemarsh came from the Stemmers Run colony.

In the fall of 1930, Mr. A. Howard Johnson, Centerville, reported finding a nest in a fence post on a farm near Centerville. On the evening of October 7th a visit was made to the nest and after dark the entire colony of wasps and their nest were removed from the post. Arriving at the farm shortly before sun down, considerable time was spent in watching the return of the field workers. The wasps continued to arrive as long as there was any light. In fact, the last few wasps came in so late that they could not be seen. The loud buzzing announced their arrival and by flashlight the landing and entrance was observed. The post was about twelve inches square and had a cavity due to splitting of the post and subsequent fungous decay. The cavity apparently was enlarged and smoothed by the wasps. The nest extended from a point near the ground, where there was an opening, to about three feet upwards in the post and slightly above a second opening on the other side of the post.

After a carbon bisulfide fumigation, the post was chopped open and all of the nest was removed together with all of the inhabitants. A total of 413 individuals in all stages were taken from the nest. These were divided as follows: queens 29, males 116, workers 142, pupae 95, larvae 31. The nest consisted of a series of combs arranged in size to conform to the cavity, the largest being about six inches in diameter. These were attached by a pedicel to the next comb and in some instances to the sides of the cavity, though most of the tiers hung free of the sides. The worker cells averaged 9.5 mm. in diameter by 17.8 mm. in depth; male cells 10.6 mm. in diameter by 25.6 mm. deep with a cap of 4-6 mm. higher; queen cells average 26.2 mm. deep with a similar cap. The general appearance of the comb corresponded very closely with the coloration of the material in the rotted portions of the post. The back and sides of the comb have a much more brown and yellowish tone than the nest of the common native wasp. European and other writers claim that the green parenchyma is used in the structure of the

nests, but not enough injury has been observed on lilacs in Maryland to warrant the assumption that green lilac wood is used in the nests. It is possible, of course, that the green material is obtained from forest trees and shrubs where the injury would not be readily observed. The writer feels that dessicated wood must play some part in the building of the nest.

On the 8th of October an orchard at Cordova in Talbot County was visited where the wasp was at work on apples, both on the ground and on fruit hanging on the trees. Apparently, once an apple is attacked, the insects continue to hollow it out until nothing but a shell remains hanging on the tree. While the number of apples so injured was small, the wasp might well multiply to such an extent that considerable injury could be done to an orchard. In this orchard casual collecting netted two males and thirteen workers mostly from fruit on the ground that was being hollowed out.

PRESIDENT FRANKLIN SHERMAN: We will now listen to a paper by G. A. Filinger.

THE EFFECT OF TEMPERATURE ON FEEDING AND DEVELOPMENT OF THE GREENHOUSE LEAFTYER, *PHLYCTAENIA FERRUGALIS* HB.

By GEO. A. FILINGER, *Wooster, Ohio*

Temperature has long been recognized as exerting a profound influence on biological processes. An extended series of papers have appeared dealing with the effect of temperature on the development of various insects but comparatively few show the total amount of food consumed by insects at different temperatures. Since injury caused by insects is in a measure proportional to the amount of food eaten, it would seem that this is an important factor to consider. The fact that insects feed and grow slower at temperatures below optimum and that a minimum effective temperature is finally reached, is well known. This was again demonstrated by the writer when he put twenty-five newly hatched leaftyer larvae into each of six constant temperature cabinets ranging from 30° C. to 5° C. The larval periods varied from 11 days at 30° C. to 60 days at 15° C. Below 15° C. the larvae failed to pupate. The last larva to die at 10° C. was 171 days old.

The present experiment was set up to determine, if possible, the total amount of food eaten by greenhouse leaftyer larvae from the time they hatch until the prepupal stage when they quit feeding. Calendula

was used for food. Circular pieces one inch in diameter were cut from the leaves of growing plants and put into rearing dishes. Newly hatched larvae were placed on the disks and the dishes put into constant temperature cabinets at four different temperatures, viz. 30° C., 25° C., 20° C., and 15° C. Twenty-five larvae were put into each cabinet. An equal number of disks were put into check dishes and kept in the same cabinets. To make sure that twenty-five larvae were always feeding in each cabinet, extra larvae were kept at each temperature and were used to replace any that died or disappeared. After the larvae had fed on the disks for some time, fresh disks were placed in the dishes. The uneaten portions of the disks were dried in a drying oven. Check disks from each cabinet were also dried. The disks were allowed to accumulate until the larvae were mature. The disks were then weighed on analytical balances. The difference in weight between the checks and the uneaten portions removed from the rearing cages gave the amount of dry weight eaten by the larvae, as shown by the table. The length of the larval period was also recorded in each case as well as the total number of adults that emerged from each cabinet.

The calendula leaves were found to contain 92% moisture and on this basis may be calculated the amount of green weight consumed.

TABLE 1. SHOWING AMOUNT OF FOOD EATEN BY GREENHOUSE LEAFTYER LARVAE AT DIFFERENT TEMPERATURES, LENGTH OF TIME FROM HATCHING TO PREPUPAE AND THEIR EMERGENCE

Temperature	Amount Eaten mg. dry wt.[1]	Time for 50 Per cent to Mature to Prepupae[2]	Per cent Emerged[2]
15° C.....	868	58 days	12
20° C.....	870	22 "	46
25° C.....	815	12.5 "	38
30° C.....	735	11 "	8

[1]Each amount based on 25 larvae.
[2]Each based on 50 larvae.

DISCUSSION OF RESULTS. The table shows that there was slightly more food consumed at the cooler temperature than at the warmer temperatures. The difference, however, is not very great. The amount eaten at 20° C. was slightly more than at 15° C. As would be expected, the rate of development varied at the different temperatures. At 30° C. the larval period was 11 days while at 15° C. it was 58 days. These figures represent the time when 50% of the larvae reached the prepupal stage.

A large number of prepupae in the cabinet at 30° C. started to spin cocoons but died without pupating. It may be that if growth is rapid and feeding period short, an insufficient amount of food is stored to

provide energy for pupation. This may explain why greenhouse leaftyers are not troublesome during that part of the year when temperatures in the greenhouse are above 30° C.

Many of the larvae kept at 15° C. died in the prepupal stage without even attempting to spin cocoons. The table shows that the amount of food eaten at this temperature was about the same or slightly less than at 20° C., yet the larval period was more than twice as long. There is no doubt but that energy is required for the mere process of living, hence it may be that this drain on the insect, extended over a long period of time, prevented the accumulation of sufficient reserve food to permit pupation.

Since the foregoing data seems to correspond quite closely to the behaviour of the greenhouse leaftyer under normal greenhouse conditions it seems safe to conclude that the optimum temperature range of this insect is rather limited.

PRESIDENT FRANKLIN SHERMAN: The next paper will be read by Ray Hutson.

THE CHERRY CASE-BEARER, *COLEOPHORA PRUNIELLA* CLEMENS, IN MICHIGAN

By RAY HUTSON, *Department of Entomology, Michigan State College*

ABSTRACT

A survey of the present distribution and abundance of the cherry case bearer in Michigan, with data upon the damage inflicted.

It is only within the last few years that the cherry case-bearer, *Coleophora pruniella* Clemens has been known as a pest in cherry plantings, although it has been mentioned as occurring on wild black cherry from time to time since its description in 1861. Granovsky in 1930 reported serious damage to cherries by it in Wisconsin, and recorded its occurrence on apple and on paper birch. Cherry case-bearer has also been reported from Quebec as a pest on apple. Michigan records on cherry case-bearer begin with material received in November 1929 from Grand Traverse County.

During July and August of the past summer, the cherry orchards of the Grand Traverse region were examined for the presence of this insect. This survey showed the cherry case-bearer infesting cherry plantings in Grand Traverse and Benzie Counties. The infestation is general over the "Old Mission Peninsula" which extends into Grand Traverse Bay, while scattering infestations are found elsewhere in the

two counties. The solidly infested area of the Mission peninsula comprises a strip of sandy land approximately 25 miles long and 3 miles wide. Within these limits there are over 350,000 cherry trees about equally divided between bearing and non-bearing trees. Over 90% of the number are sour cherry. No correlation between type of cherry and infestation was apparent despite the widely varying numbers of young case-bearers in different orchards.

In the generally infested area almost all the eggs of this pest were deposited the past season between July 15, and July 25. As a consequence, the young larvae were abundant during the first two weeks in August. Damage to the leaves, mistaken by most growers for shot hole fungus, began to be noticeable during the first week in August. It was at this time that the counts forming the basis of the following tables were made. The counts were obtained by selecting limbs at random from five trees in as many parts of the most heavily infested orchard seen and counting all the leaves, and all the yellow leaves showing mines separately.

TABLE 1. PERCENTAGE OF YELLOW LEAVES (FOLIAGE LOSS) DUE TO MINES OF *Coleophora pruniella*

Tree	Yellow Leaves	Total Leaves	Per cent Yellow Leaves
No. 1.....	76	1163	6.5
No. 2.....	39	828	4.7
No. 3.....	93	1647	5.5
No. 4.....	72	1724	4.1
No. 5.....	108	3038	3.2

These counts were made on August 6 at the time the injury was just becoming apparent. The trees were then marked, the yellow leaves removed, and the counts repeated August 11, the data at that time indicating about the same percentage of additional functionless, yellow leaves. Since by the latter date over 90% of the case-bearer larvae had emerged from their eggs, the two counts together show an infestation resulting in the direct loss of six to thirteen per cent of leaves. This was with a possible further loss of one to two per cent of the total leaves from the injuries by larvae hatching afterward.

On August 6 when the first counts were made, 207 yellow leaves under a binocular microscope showed 786 eggs and mines. Many leaves were just as surely killed by one or two mines upon the basal part as others were by several on the apical end. The largest number of eggs on a single leaf was 23.

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(Unpublished correspondence)

Vice-President J. S. Houser assumed the Chair.

VICE-PRESIDENT J. S. HOUSER: We will now listen to a paper by F. C. Bishopp and R. D. Wagner.

NICOTINE IN THE CONTROL OF ECTO-PARASITES OF POULTRY

By F. C. BISHOPP and R. D. WAGNER, *Division of Insects Affecting Man and Animals, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The results obtained with nicotine sulphate in controlling the feather mite, ***Liponyssus silviarum***, and the common chicken mite, ***Dermanyssus gallinae***, are summarized. A series of tests are detailed. The treatment is effective for the fowl tick, ***Argas miniatus***. With reasonable care, there are no serious effects on the fowls.

Since the discovery in 1928 by a poultryman in California that nicotine sulphate when applied to the roosts of chicken houses would destroy chicken lice, much attention has been directed to this method of combating these troublesome pests. The simplicity of the treatment and the presence of large numbers of dead lice beneath the roosts following the application have made a strong appeal to the poultry owner, and as a result the method has come into rather wide use. The poultry departments of a number of experiment stations, notably those of New Jersey, Delaware, Maryland, California, and others, have conducted practical tests of nicotine sulphate against lice, but very little work has been done by entomologists to truly evaluate and analyze the method, and compare the results with those obtained from the now well-established sodium fluoride treatment for poultry lice. Furthermore, practically no information has been published with reference to the use of nicotine products against ectoparasites of poultry other than lice and the feather mite, *Liponyssus silviarum* Can. & Fanz.

While our own work is far from complete, the widespread interest in nicotine sulphate in the control of external parasites of poultry makes it desirable to present some of the data thus far secured.

NICOTINE SULPHATE AGAINST THE FEATHER MITE AND COMMON CHICKEN MITE. In 1929 Mr. C. R. Cutright[1] published a note on the use of nicotine sulphate against the feather mite, *Liponyssus silviarum*. Some tests of nicotine sulphate against this mite have also been reported by Professor L. F. Payne,[2] and Mr. E. L. Taylor[3] states that an infestation of this mite in a poultry house in Dorchester, England, disappeared as a result of two treatments of the perches with nicotine sulphate and paraffin.

Our experience with the feather mite indicates that a single treatment of the roosts with nicotine sulphate can not be relied on to clear out an infestation. The number of treatments necessary for eradication depends on the extent of infestation and whether supplemental control steps, such as removing the litter, and spraying or dusting the house and nests, are carried out at the same time the roosts are treated.

Nicotine sulphate was found to be very effective against the common chicken mite, *Dermanyssus gallinae* L., when applied pure or diluted with 9 parts of water. Tests carried out by the senior author several years ago showed that nicotine sulphate when used as a spray in mite-infested chicken houses in such strengths as are usually employed against insects on plants was ineffective. W. M. Davidson[4] made tests against mites with aqueous solutions containing 0.07 and 0.12 per cent free nicotine with the addition of 4 pounds of whale oil soap to 100 gallons. He concludes that these sprays "were of some value, especially the stronger solution."

Most of our practical tests with mites consisted of thoroughly spraying infested chicken houses with 1 part of 40 per cent nicotine sulphate in 9 parts of water; then closing the houses up for about eight hours. These tests were carried out in July when the temperatures were high. On the day following the application it was noted that the mites were greatly reduced in numbers and by the end of the third day no live mites could be found and there was no recurrence of the infestation. One similar test of 40 per cent nicotine sulphate diluted 1 to 50, with 1 ounce of soap per gallon added, gave satisfactory control.

[1]Cutright, C. R. A valuable aid in the control of the feather mite, *Liponyssus silviarum*. Jour. Econ. Ent., v. 22, p. 422. Apr., 1929.

[2]Payne, Loyal F. A new method of controlling feather mites. Jour. Econ. Ent., v. 22, p. 819–820. Oct., 1929.

[3]Taylor, E. L. *Liponyssus sylviarum* injuring poultry in this country. Parasitology, v. 22, no. 3, p. 313. June, 1930.

[4]Davidson, W. M. Results of experiments with miscellaneous substances against the chicken mite. Dept. Bull. No. 1228, U. S. Dept. Agr. 10 p. 1924.

That the mites are killed by the fumigating effect of the nicotine as well as by direct contact is shown by a test in which small double wooden strips were painted with nicotine sulphate; then the mites were put between these on the unpainted surfaces. All those introduced 24 hours after the application died in a few hours. Of those introduced 48 hours after the application, 50 per cent died, and none of those were killed which were put on 96 hours after the treatment. Other tests also clearly indicate that mites are slowly killed if confined in boxes the floors of which have been lightly treated with nicotine sulphate. The mites in these tests had no contact with the treated surfaces.

Tests Against the Fowl Tick and Sticktight Flea. Two tests of 40 per cent nicotine sulphate, 1 part to 9 parts of water, were made against the fowl tick, *Argas miniatus* Koch. The material was applied to the infested poultry houses with a sprayer. Satisfactory control resulted. Even those ticks which were protected from the direct application of the spray were killed, apparently by the vapor. The treatment, however, is more expensive and the effects less lasting than when anthracene oil is used.

In experiments with nicotine sulphate against the sticktight flea, *Echidnophaga gallinae* Westw., it was found that the application of nicotine sulphate to the perches did not destroy the adult fleas attached to the heads of the fowls. Spraying the floors of infested poultry houses with 40 per cent nicotine sulphate diluted with from 4 to 9 parts of water and making a moderate but thorough application destroyed all adults present.

Experiments in Control of Chicken Lice. The method of treatment generally used against lice consists of making a light application of 40 per cent nicotine sulphate to the upper surface of the perches about half an hour before the fowls go to roost.

There is little opportunity for the material to come into direct contact with the lice and evidently their destruction is brought about largely by fumigation. The feathers cover a considerable part of the roost beneath the fowl, and body heat hastens volatilization; and evidently the fumes pass upward through the feathers and hence rather promptly reach the lice on the legs, bodies, and wings. If there is any nicotine sulphate which has not thoroughly dried into the perches when the fowls go to roost it is distributed through the feathers to some extent by the scratching of the fowls, and some of it gets smeared on the feathers by contact.

The lice may begin to crawl to the surface of the feathers in about half an hour after the fowls go to roost and some begin dropping off

practically dead soon after they appear. Free nicotine is rather more rapid in its action, as lice may begin to drop off fifteen minutes after exposure to it.

Most of our experiments were carried out under practical poultry farm conditions in the vicinity of Washington, D. C. The houses used were built of lumber, and the construction was fairly tight with ample ventilation secured through the open fronts. The nicotine sulphate or free nicotine was applied lightly with a brush to the entire upper surface of the perches from one-half an hour before to immediately prior to the roosting of the fowls. In each test a number of fowls were leg-banded and examined prior to treatment, and a record made of the species of lice found and degree of infestation of each. Papers were spread on the dropping boards under some of the fowls, and the dead lice were collected the following morning, counted, and the species determined. The leg-banded chickens and others were then examined the day following the treatment and at intervals for weeks or months thereafter. Other tests were made on groups of heavily infested fowls kept in coops in the laboratory yard. Mr. Harold S. Peters carried out one of these tests in the fall of 1928, and the others were made in 1930.

The temperature in the hen houses at the time of application ranged in different tests from 60° F. to 91° F., and the minimum temperatures during the night following the treatments ranged from 43° F. to 85° F.

In most of these tests the flocks were very lightly to heavily infested with five species of lice: the body louse, *Eomenacanthus stramineum* (Nitzsch); the shaft louse, *Menopon gallinae* (L.); the fluff louse, *Goniocotes hologaster* Nitzsch; the wing louse, *Lipeurus caponis* (L.); and the head louse, *Lipeurus heterographus* Nitzsch.

A large percentage of the lice were killed during the first night following an application, some were killed the second night, and a few the third night. The eggs were not all killed; in fact, the precise effect on the eggs was not determined. Although some of the lice which dropped off the fowls were found to be alive, these were noticeably affected by the treatment and soon died.

In all tests the treatment was more effective against the body, shaft, and fluff lice than against the wing louse, and the head louse was least effectually controlled. Doubtless the location of the last named species on the birds, mainly on the head and neck, exposes it less to the concentrated vapor of the nicotine, especially if the head is not kept under the wing. In no case were all head lice killed except in laboratory tests, in which the fowls were kept in rather tightly closed boxes.

A series of tests was conducted to determine the interval between applications which would be most effective and the possibility of completely destroying lice by repeated treatments. These tests were not conclusive owing to the practical difficulty in keeping all fowls on the roosts the night following each treatment and in making sure that no mixing of fowls from different pens took place during the long period required for the tests. It was evident, however, that an interval of six days was too short. Many eggs were observed to hatch after the second treatment. Intervals of 12 and 20 days apparently gave an opportunity for some of the lice to mature and lay eggs between the treatments. The 8-day interval gave best results, as with this interval no hatching was observed after the second treatment.

Tests were made of different methods of application, such as: tacking a strip of cloth soaked in nicotine sulphate to the top of the perches; applying the nicotine with an oil can; applying the material with a brush to the bottom sides of the perches; and making general applications to the roosts, dropping boards, and walls with a sprayer, as would be the case in treating for mites. The even distribution of the material with a brush over the entire upper surface of 2-inch perches seemed to be as effective as any of the other methods. Painting the dropping boards or bottoms of the perches only was effective.

The results secured by the use of free nicotine were practically identical with those obtained by use of nicotine sulphate, but the application of the former is more disagreeable, and its greater volatility makes it necessary that more ventilation be provided for the fowls than when nicotine sulphate is used.

Effect of Nicotine on Poultry. Numerous tests of nicotine sulphate by poultry departments of several experiment stations and by practical poultry owners as well as those conducted by us, indicate that no noticeable injury to the fowls results if the applications are properly made and there is sufficient ventilation. Some reports of injury or death of fowls have reached us, these being due apparently to excessively heavy applications or poor ventilation or a combination of the two. No reports appear to have been published on the effect of the treatment on egg production. In our experience, a drop in the number of eggs produced the day following an application was observed in some cases, but the next day the decrease was usually made up, and then normal production was resumed. Free nicotine has produced no markedly injurious effects in our tests, but it is certain that its use is fraught with some danger. The toxic effects of the fumes when fowls are kept in

close confinement are much more quickly apparent than in the case of nicotine sulphate. This also suggests the need for caution when nicotine sulphate is applied to poultry houses which have been whitewashed or limed, since lime in combination with nicotine sulphate releases free nicotine.

SOME ADVANTAGES AND DISADVANTAGES OF THE USE OF NICOTINE SULPHATE AGAINST LICE. The short time required for the application of nicotine sulphate to the perches as compared with the individual treatment of the fowls with sodium fluoride or sodium fluosilicate is a distinct advantage, as is also the fact that the fowls are less agitated by the nicotine treatment than when handled individually. The cost of a single application of nicotine sulphate is also less than a treatment with sodium fluoride owing to the saving in labor. Certainly many poultry owners would carry out this simple treatment when they would not take the time to dip or dust the fowls individually.

There are several disadvantages to the nicotine sulphate treatment as compared with that of sodium fluoride. The principal one is that eradication of all lice is not accomplished by one treatment; in fact, even with many repetitions of the treatment some head lice may persist. It is difficult to get poultry owners to apply a second treatment at the proper time, if at all. If all fowls do not roost on the treated perches, the infestation will soon spread from those fowls which are not subjected to the fumes. Moreover, effective control with nicotine sulphate is dependent upon having the flock in a comparatively tight house, free from strong drafts, yet with proper ventilation to protect the fowls from injury. In very open houses, such as are commonly used in the South, still nights must be selected for treatment. There is a valid argument in favor of individual treatment of fowls over mass treatment, especially when it is only required once or twice a year or even less frequently; this is that the flock owner has to handle every bird and can do culling and become familiar with his stock at the same time he treats for lice.

MR. C. R. CUTRIGHT: We located a very severe infestation of the feather mite about two years ago in Wooster, Ohio. It was so severe that frequently 5 to 50 mites per day would be found on the eggs when gathered from the nests. There were about 2500 birds on this farm and all were infested.

The houses were treated with one application of nicotine painted on the roosts. Within 24 hours after application not a single mite could be found on the birds. Application was repeated two weeks later, and I have watched the place for two years since that time and none of these

mites have been observed, although no additional treatment has been applied.

VICE-PRESIDENT J. S. HOUSER: The next paper is by A. A. Granovsky.

CONTROL OF THE CHERRY CASE-BEARER, *COLEOPHORA PRUNIELLA* CLEM., BY OIL SPRAYS

By A. A. GRANOVSKY, *St. Paul, Minn.*

(Paper not received in time for publication)

MR. L. M. PEAIRS: What was the percentage of dilution and when was it applied?

Mr. A. A. GRANOVSKY: Six or eight per cent of paraffin oil gives the best control. Some proprietary oils have been used with varying results. On the whole they were not as satisfactory as those that I first mentioned. We applied these sprays yearly in the spring at the time when the buds were beginning to break.

President Franklin Sherman resumed the Chair.

PRESIDENT FRANKLIN SHERMAN: The next paper is by W. P. Yetter and L. F. Steiner.

A PRELIMINARY REPORT ON LARGE SCALE BAIT TRAPPING OF THE ORIENTAL FRUIT MOTH IN INDIANA AND GEORGIA

By W. P. YETTER, JR., *Vincennes, Ind.*, and L. F. STEINER, *Cornelia, Ga.*

(Paper not received in time for publication.)

PRESIDENT FRANKLIN SHERMAN: L. A. Stearns will now present his paper.

THE BROODS OF THE PLUM CURCULIO, *CONOTRACHELUS NENUPHAR* HERBST, IN DELAWARE[1]

By L. A. STEARNS, *Entomologist, Agricultural Experiment Station, Newark, Delaware*

ABSTRACT

Preliminary data recorded in an investigation relating to the bionomics and control of the Plum Curculio, *Conotrachelus nenuphar* Herbst, in Delaware, indicate that climatic factors, notably temperature and precipitation, may not be the primary agencies contributing to the development of two broods within a certain year and apparently warrant a suggestion concerning the possible existence of one and two-brooded strains of this insect.

The Plum Curculio, *Conotrachelus nenuphar* Herbst, is a native North American insect, occurring in varying abundance east of the Rocky

[1]Paper of the Journal Series, Delaware Agricultural Experiment Station, Department of Entomology.

Mountains in the United States and southern Canada. Early horticultural writings and entomological literature of the last twenty-five years abound with references to its depredations, which definitely establish its status as a major pest of practically all stone and pome fruits.

Considerable uncertainty is apparent in the variety of opinions which have been expressed concerning the number of broods of this insect developed annually in those areas within which severe injury has been experienced and wherein its seasonal life history and control have been subjected to more or less extensive investigation.

REVIEW OF LITERATURE. Although Scott and Quaintance—1911 (1)[2] and 1918 (2), stated that there was some evidence to indicate that there might be a small second generation in the South, they assumed it to be comparatively insignificant and concluded that for practical purposes the insect produces but one generation each year. Snapp—1923 (3), however, summarizing the results of studies conducted during 1921 and 1922, asserted that two generations occur annually in the latitude of central Georgia and considered a high percentage of the larvae that render the best, late varieties of peaches unmerchantable in that State to be those of the second generation. Leiby and Gill—1923 (4), and Leiby and Harris—1925 (5), reported the development of two broods in North Carolina during the same period. On the contrary, and according to Snapp—1927 (6), only one generation developed in Central Georgia in 1923 and but a partial second generation in 1924. Howard—1927 (7) stated that a partial second generation might develop in Indiana in certain seasons and Chandler—1927 (8) recorded the rearing of a second brood in Illinois that year. Sanders—1928 (9), however, although conceding the possibility of more than one brood in Maryland some years, declared that there had been only one destructive brood each year for the past five years and Cagle—1930 (10), maintained that the outbreak in the Charlottesville-Crozet section of Virginia in 1929 was not due to a second brood of Curculio.

It is obvious, from this brief review of the literature, that only within the past few years has the existence of two broods of this insect been recognized and furthermore, that the accumulative data indicate the possible occurrence of either a whole or a partial second brood farther and farther north thruout the general area of its distribution.

BROOD STUDIES IN DELAWARE. As a result of the increasing and extremely heavy losses from Curculio experienced by both peach and

[2]Reference is made by number in parenthesis to literature cited at conclusion of paper.

apple growers in certain sections of Delaware, which had aroused the suspicion that two broods were being developed annually in that State, a project relating to the bionomics and control of this insect was initiated in the spring of 1928 by the Department of Entomology of the Delaware Agricultural Experiment Station.

During that year, the seasonal life history studies conducted at the Newark insectary in New Castle County (northern Delaware) and at the Camden insectary in Kent County (central Delaware) were supplemented by occasional observations on development in orchards at Bridgeville in Sussex County (southern Delaware). In 1929, an insectary was erected at Bridgeville and seasonal life history records have since been obtained for all three localities.

The results of the studies at Newark and Camden, during both 1928 and 1929, indicate that the Curculio is normally single-brooded in those sections. At Bridgeville, on the contrary, a partial second brood, developing in 1929, caused severe injury late in the season comparable with that experienced annually in that district over a period of years.

Seasonal differences in Curculio development have, up to the present time, been commonly attributed to and apparently correlated with variation in temperature and precipitation. Delaware comprises an area of but 2,370 square miles, approximately 125 miles in length and varying from 10 to 45 miles in width, with an annual mean temperature of 55.0 degrees and an annual total precipitation of 42.85 inches. The three insectaries, aforementioned, represent a series of observational points of which Bridgeville is the most southern; Camden, 30 miles to the north; and Newark, 45 miles still farther north. The maximum variance in elevation is but 62 feet and the maximum departure from state normals for temperature and precipitation, but 0.5 of a degree and 0.98 of an inch, respectively. Within such a small area and under such uniform climatic conditions, it seemed possible that some factor other than temperature or precipitation might be the determinant in brood development.

Accordingly, during 1930, seasonal life history studies with Curculio collected at Bridgeville, Millsboro and Milton in Sussex County, at Camden in Kent County and near Wilmington in New Castle County were conducted in triplicate at each insectary. The resulting data indicate that certain Curculio from southern Delaware are apparently capable of developing a second brood at all points and those from central and northern Delaware but a single brood, when reared under identical conditions.

Although Curculio appear from hibernation slightly earlier in the southern as compared with the central and northern sections of the State, developmental differences become proportionately less pronounced as the season advances. During the first week in June, mature, first brood grubs are issuing from drop peaches at all points and, during the last week in the month, first brood adults are emerging from the soil. In 1930, notwithstanding the fact that emergence of the first brood adults commenced June 27, it was only a certain group of Curculio emerging between July 3 and 10 that deposited eggs between July 12 and 18 from which second brood adults were reared. In this connection, it is of special interest to note that during the present year the first appearance of Curculio from hibernation and the first issuance of mature, first brood grubs from drop peaches occurred four weeks earlier and the emergence of first, first brood adults, three weeks earlier in Georgia[3] than in Delaware, but deposition of the first, second brood eggs was recorded on approximately the same date.

CONCLUSIONS. The purpose of this paper, presenting these preliminary data, is to suggest that temperature and precipitation may not be the controlling factors responsible for the development of two broods of Curculio within a certain year and to register the possibility of the existence of one and two-brooded strains of this insect.[4] Plans are being formulated for investigation of Curculio development under conditions of regulated temperature and humidity and for cross-breeding of one and two-brooded Delaware Curculio supplemented by breeding studies with material secured from sections of the country in which this insect is normally two-brooded, occasionally two-brooded and normally one-brooded.

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PRESIDENT FRANKLIN SHERMAN: We will now listen to a paper by F. Z. Hartzell and F. L. Gambrell.

RELATION OF ENVIRONMENT TO PEAR PSYLLA INFESTATION

By F. Z. HARTZELL and F. L. GAMBRELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

The degree of infestation by pear psylla, *Psyllia pyricola*, was observed to be related to the environment, and this led to an investigation of the factors that favored or hindered the destructiveness of the species. It was found that heavily infested trees usually were located in sheltered places, and that orchards in which the insect generally was scarce were situated where they were exposed to north, northwest or west winds. It is believed that much of this influence is confined to the autumn dispersion, at which time the migrants seek trees in sheltered places perhaps because of quiet and warmth. A part of these results may be due to the action of storms which wash some of the nymphs from the trees where the latter are not protected. The study is aimed at a determination of the intensity of the various forces of the environment that produce these results, with the object of making possible recommendations for modifying the surroundings of existing pear orchards so as to reduce to a minimum the destructiveness of this pest. Another object is to assist growers in the location of new plantings to secure the same ends. Additional investigation is planned to secure more data on the problem, which seems important in view of the decreased cost of psylla control that would be made possible.

All entomologists who have labored with problems relating to pear psylla (*Psyllia pyricola*) no doubt have noted the wide variation in the density of population of this insect in different orchards during the same brood. A project, begun in 1927, has been conducted, when time permitted, with the object of determining the natural forces which make

pear trees unfavorable for the multiplication of the pest. This is a preliminary report of the progress of the study giving conclusions based on the observations and data secured.

HISTORY OF THE INVESTIGATION. In the course of insecticide investigations for the control of pear psylla during 1926 and 1927 the senior author had occasion to visit many pear plantings in central New York. During such visits careful observation, in many instances supplemented by counts, were made of the relative infestation in different orchards and in various parts of the same orchard. In some instances the population was excessive, in other cases the number of psylla was rather light, while all manner of gradation between these extremes were present in near-by blocks during the same brood. Incidentally, the history of each lot of trees was secured from the owner as regards age, yield, and insect pest. At the same time, observations and notes were made of the surrounding conditions. From these studies it soon became apparent that variation in infestation was not a matter of chance.

Analyzing the data secured, the following facts presented themselves, after eliminating differences that may have been due to pear varieties: (1) The same relative abundance occurred each year in the various plantings, and frequently in the same orchard; (2) psylla had been a serious pest in certain places practically every year, while in others its destructiveness was limited to seasons when the insect was especially abundant thruout the region; and (3) instances were found where it was claimed that no treatment had been made for at least twenty years, yet the insect had never been sufficiently numerous to injure or mar the fruit, notwithstanding the fact that orchards in the vicinity were so seriously injured that remedial measures were needed practically every season. The amount of parasitism did not warrant the conclusion that this was a factor of sufficient importance to cause the differences mentioned.

It was noted that variation in infestation was correlated with environmental differences, and of the various possibilities it seemed that shelter from wind was an important consideration, so an effort was made to determine the factors involved. A comprehensive investigation was begun in 1927 in which psylla population studies and tree crown measurements were made in several orchards by the junior author, while the senior author set himself the task of making population studies and of surveying to secure data relating to the environment which is to serve as the foundation for studies of the effect of surroundings on

climatic and other factors. The surveys will also make possible the accurate mapping of the areas for the purpose of illustrating the surroundings and their influence on the several elements that operate to change the density of psylla population. In conjunction, both authors made controlled photographs of a number of the areas. The examples selected for intensive study are orchards and surroundings that are typical of western and central New York and that have varying degrees of psylla infestation. The studies were not continuous, but were prosecuted when time could be spared from other experimental investigations.

OBSERVATION AND HYPOTHESES. The data and observations to date indicate that (1) trees exposed to north, northwest, or west winds usually are not seriously infested by psylla, and (2) differences in infestation are closely correlated with the amount of shelter to the north and northwest of the orchard, being specially marked when both sides are protected. Shelter may be afforded by different features of the terrain adjacent to pears, of which the following are given in increasing order of importance: (1) The pear orchard itself; for example, in large plantings where outside protection is absent the trees on the north and west sides may be free from psylla and those in the east and southeast portion rather heavily infested; (2) tall trees situated rather close together along fences; (3) apple orchards; (4) elevations of land with steep slopes; (5) the farm house complex, consisting of buildings and surrounding trees; (6) hedges of tall evergreen trees; (7) dense woodland; and (8) a combination of several of the above features.

The exact reason for northerly and westerly winds exerting this influence has not been determined, but a study of the facts at hand leads to the view that these winds are largely responsible for three conditions that are unfavorable to the insect; namely, cold and agitation of the trees during the migration periods and storms during the nymphal periods. As has been shown, (1, 2) pear psylla adults do not migrate very far during the spring and summer, 600 feet being the maximum distance observed in one series of studies in which measurements were made. Repeated observation of movement of adults during the summer would set the maximum distance at not much over 1000 feet and the average considerably below this figure. The most extensive dispersion occurs in the autumn (1, 2) at which time the winged creatures appear to fly for several miles in their effort to scatter the species. During this migration the adults tend to congregate in those orchards or portions of others where warmth and quiet are most marked, which conditions

naturally would be found on trees sheltered from north and west winds. In New York winds from these quarters, especially in autumn, are considerably colder and of higher velocity than from the south or east.

Rains accompanied by wind with a velocity of twenty or more miles per hour (in this paper called "storms" for brevity) wash many of the nymphs from the leaves. This action was especially strong during the stormy period in June, 1930, at which time the first-brood nymphs were present. The number of nymphs was reduced almost to zero on exposed trees. In most of these storms the wind was from the west or northwest. When these creatures are washed from the trees they do not seem able to regain their feeding places. That the nymphs are easily dislodged by rather forcibly driven water is shown by a test made in 1929 to determine the mechanical effects of spraying. Trees were treated with water alone, using a spray-gun, with the operator on the ground, simulating regular spraying (i.e., not using a solid stream against the foliage) and counts revealed a reduction in the number of nymphs of 31 per cent. The force of the water was not greater than occurs in an ordinary storm, and was less than accompanied some of the storms observed.

Further Investigations Needed. Altho the facts given above are based on considerable quantitative data, further work is needed and plans have been made for its prosecution. The following are some of the major aspects of the problem; namely, (1) effect of the size, height, and location of an obstruction on the velocity of the wind and air temperature at different heights above ground; (2) more quantitative data relative to the autumn dispersion of psylla, including distances traveled, relation between direction of the migration and direction and force of the wind, also the effect of temperature on the movement; (3) correlation between the following factors: wind velocity, temperature and number of insects that locate in a given spot; (4) effect of storms and of wind, not accompanied by rain, on the death rate of the nymphs; and (5) the action of these several factors on the number of parasitic and predaceous enemies.

This study was started not with the idea of a mere investigation of the ecological influences affecting the insect nor to show its aeronautical ability, but with the object of finding practical means for diminishing the pear psylla population of orchards by aiding the operations of the forces of nature. Specifically, the aim is to determine the amount of shelter to be avoided or removed to give the minimum infestation. Such

information should enable entomologists and perhaps growers to make certain measurements and from these determine definitely how much change in conditions would give practical relief for existing orchards and to state where new plantings could be made with the assurance that this insect would not prove a menace and expense; at least for four years out of five, or any other ratio. The knowledge obtained should also make possible a determination of the maximum size of the orchard consistent with good natural control of the insect. The data show that the surest way to invite psylla into pear trees is to have large, well sheltered plantings.

IMPORTANCE OF THE PROBLEM. Owing to the low profits in pear growing and the destructiveness of the pear psylla, this investigation shows promise of offering a solution to control at a minimum expense. The surroundings of many existing orchards can be modified at a comparatively low cost. In the selection of sites for new plantings the results of these studies should offer considerable assistance to the pear grower who desires to lessen the attack of this insect. It seems that the wind can be employed more economically for the control of the pest than any other method.

CONCLUSIONS. Abundance of pear psylla appears to be chiefly related to the degree of shelter afforded an orchard from northerly and westerly winds.

Those plantings examined in which the insect has been serious from year to year were found to be protected to the north, northwest or west by their own size, by trees, apple orchards, elevation of land, the farm house surroundings, hedges of tall evergreen trees, dense woodland, or a combination of several of these factors.

In some instances orchards were found where remedial measures for pear psylla have never been necessary, altho nearby blocks were severely infested. Such immune places were invariably exposed to north or west winds. It is believed that the chief influence of wind on the insect is during the autumn dispersion when the migrating forms seek trees where greater calm and warmth prevails than in other places in the same area. Storms remove many nymphs from the trees and, owing to the velocity of the wind being higher where no protection is afforded, the exposed trees show the greatest per cent of mortality. This influence may be very important during seasons when the rains are accompanied by high winds.

Further investigation is needed to determine the intensity of the various factors in an environment that tends to favor or retard increase in the number of pear psylla.

The aim of the project is to determine the amount of shelter that should be removed or avoided to give the minimum infestation, with the object of being able to assist pear growers in determining how to change existing conditions or to set out new orchards where the danger from infestation will be greatly reduced.

The importance of the problem may be judged from the necessity of reducing the cost of psylla control in view of the low returns from pear growing.

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INVESTIGATIONS AIMED AT REDUCING THE COST OF PEAR PSYLLA CONTROL

By F. Z. HARTZELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Pear psylla, *Psyllia pyricola*, control is intimately related to other problems of pear production. Owing to low profits from the various causes discussed, the greatest economy must be practised in combating this insect. Results of investigations show that this may be accomplished in part by modifying the environment of the orchard, by the use of lubricating oil emulsions, and by decreasing the proportion of nicotine. Experience has shown that care must be exercised in the use of oil sprays on weak trees.

Any system aimed at combating the pear psylla (*Psyllia pyricola*) that does not take into consideration all the problems of pear production, including profits, will not be approved by the majority of growers. Moreover, the cultural practices in vogue have a direct bearing on the development of spray injury, and the question of profits compels the entomologist to reduce to a minimum the cost of treatments. In view of these requirements it seems best to consider first the chief problems of pear growing and, later, to discuss pear psylla control.

FACTORS THAT REDUCE PEAR PROFITS. Among the chief causes that limit the net returns to pear growers in New York may be mentioned

the following: (1) pear blight, caused by *Bacillus amylovorus;* (2) uncertainty in set of fruit; (3) low prices; and (4) pear psylla. These four factors are so closely interwoven that it is difficult to assess the relative value of each, altho in many respects pear blight is the most important.

Owing to the liability of losing entire orchards from this disease and because pear blight is most destructive to trees of vigorous growth, plant pathologists have recommended, in addition to other remedies, that the system of pear culture should aim to maintain the minimum growth sufficient to produce a fair amount of fruit buds but which will not induce a succulent development of twigs. Most successful growers are practicing this system, which means that generally no orchard is kept at maximum vigor; at least for a period of years. The disease was present in epiphytotic proportions in 1930, and it was evident that vigorous orchards where blight control was not persistently practiced were, in many instances, so completely destroyed that each orchard as a whole will be left in a badly mutilated condition by removal of the blighted limbs and dead trees.

Each orchard presents a different problem as regards culture: some cannot be plowed completely every season, but a few furrows are plowed each spring until all the ground is turned over about once in four years; others can be cultivated a brief time each spring; in some, fertilizers cannot be tolerated; in others moderate applications do not produce undue susceptibility. Thru fear of over stimulation the tendency is to keep the vigor of the trees somewhat below the standard necessary to prevent the disease from doing excessive damage. In addition to reducing the net income, the weakened trees are more easily injured by certain sprays.

Eliminating spring freezes, uncertainty in set of fruit is generally caused by one of three conditions; namely, (1) failure to form fruit buds, (2) weak fruit buds, or (3) lack of pollination. The first two factors are largely the direct result of cultural practice made necessary to either avoid or minimize the loss from blight; altho sometimes they may be caused by psylla injury the previous season. Lack of pollination is due to want or sparsity of suitable varieties to fertilize the commercial kinds or is due to climatic conditions, such as cold, rain or high wind which prevent activity of bees and other pollinating insects. The leading commercial varieties are Bartlett, Kieffer, Seckel and Clapp's Favorite, which are largely self-sterile. The tendency has been to plant entire

blocks, or even entire orchards, to one variety, with the result that a light set of fruit is effected unless weather conditions are almost ideal during blossoming. More attention is being devoted to this problem so that an increasing number of growers are scattering suitable pollinating varieties thruout their plantings, at the same time being careful to avoid the use of those that are especially susceptible to blight. Barring periods of depression, one of the most potent causes of low pear prices is the production of heavy crops during seasons when there is an abundance of other fruit and a scarcity when fruit prices are high. Some growers have remedied this condition to a large extent by the addition of properly spaced pollinating varieties.

The foregoing has been written not to minimize the destructiveness of pear psylla but to show how intimately the control of this pest is related to other problems of pear culture. Pear psylla remains the most serious insect pest of this fruit when the entire state is considered, and, in view of low returns, the greatest economy consistent with effective control must be practiced in its suppression. Economy in the spray program for this insect apparently can be secured in three ways; namely, (1) by reduction in the amount of ingredients per 100 gallons; (2) use of materials that are cheaper than those used in the regular spray schedule; and (3) development of systems that require a smaller number of treatments.

Reduction in the Amounts of Ingredients. In the experiments from 1926 to 1928, Junior Red Engine Oil proved more toxic to pear trees than did Diamond Paraffine Oil, both brands being used at the rate of three per cent in bordeaux. J.R.E. at two per cent and D.P. oil at three per cent in 1929 gave the same effects on psylla, the infestation being severe in an untreated block separated less than 100 feet away. These two oils were again tested in 1930, using one and two per cent mixtures of the former and two and three per cent mixtures of the latter. While the greater dilutions of both oils appeared to control psylla as effectively as did the D.P. oil at a three per cent dilution, the infestation on the check plats was very light at the time the data were taken, therefore the results are rather inconclusive. However, considering the data for the two years, it appears that lower percentages of oil may be effective and for this reason deserve more extensive trial.

In an effort to reduce the expense of nicotine sprays, numerous experiments have been in progress during 1929 and 1930. A portion of the results of the former season have been published (1). While addi-

tional mixtures were tried in 1930, the more promising combinations used in 1929 were repeated with some changes in proportions in 1930. During the latter year from 50 to 60 trees were used in each test and the trials were made in two commercial orchards as calyx applications, but the psylla population was light. It should be noted that the tests the preceding year were summer treatments, at which time the weather was exceptionally hot and dry and that the infestation was very heavy. The results as shown in Table 1, where the same mixture, with the changes noted, was used both years two sets of data are given for comparison.

TABLE 1. NUMBER OF PEAR PSYLLA NYMPHS PER SPUR AFTER SPRAYING AND PER CENT REDUCTION APPARENTLY DUE TO TREATMENT

Materials	1930		1929	
Amount in a total of 100 gallons of Bordeaux (2-40-100) except where noted	No. of Nymphs per Spur	Per cent Reduction	No. of Nymphs per Spur	Per cent Reduction*
Orchard A, 1930				
Nicotine sulfate used in all mixtures				
Nicotine, 1 pint	0.14	97	22.1	95
Nicotine, ¼ pint	0.27	95	—	—
Nicotine, ¼ pint; Penetrol, 1 quart (2 qts. 1929)	0.23	96	2.1	95
Check	5.47	—	19.5	—
Orchard R, 1930				
Free nicotine used in all mixtures for 1930 Nicotine sulfate used in all mixtures for 1929				
Nicotine, ¾ pint	0.10	92	—	—
Nicotine, ¼ pint	0.07	95	—	—
Nicotine, ¼ pint; pine oil, 2 quarts (4 qts. 1929)	0.07	95	0.7	98
Nicotine, ¼ pint; hardwood neutral oil, 2 quarts (4 quarts 1929)	0.04	97	0.3	99
Nicotine, ¼ pint; resin fish oil soap, 3 pounds	0.07	95	—	—
Nicotine, ¼ pint; white oil 4 quarts, pine oil 2 quarts	0.07	95	—	—
Nicotine, ¼ pint; white oil 4 quarts, hardwood neutral oil, 2 quarts	0.08	94	—	—
Amount in a total of 100 gallons of water (No Bordeaux)				
Nicotine, ¼ pint; white oil 4 qts.; pine oil, 1 qt	—	—	3.5	90
Nicotine, ¼ pint; white oil, 4 qts.; hwd. neut. oil 1 qt	—	—	5.5	85
Check	1.28	—	27.2	—

*In 1929, counts of psylla nymphs were made on all the plats previous to and after treatment. This data corrected to allow for decrease on the untreated (so-called check) trees was used in computing per cent reductions, therefore the untreated trees in 1929 are not checks in the usual sense.

The per cent reduction for the two years with practically the same mixtures are slightly higher during 1929 than in 1930. This may be due

to several factors, namely, higher temperature, less rain, or may represent in some cases increased efficiency due to slightly higher concentrations of one of the ingredients in the former year. The changes were made to lessen the danger of injury since extensive tests were made in commercial orchards having a heavy set of fruit. It will be noted that nicotine at the rate of ¼ pint in 100 gallons of bordeaux gave practically the same results as did higher concentrations. The addition of other materials seemed to have added little to the efficiency when experimental error is taken into account. These results indicate that the concentration of nicotine was too great to show the effect of the so-called "activators" and that further reduction in nicotine may be possible.

USE OF CHEAPER MATERIALS. Only one type of cheaper material has been found that is effective against psylla. This is the lubricating oil emulsion which, in some instances, replaces the lime-sulfur and certain nicotine applications. Using four gallons of mixture per tree for each treatment, the cluster-bud spray and two summer applications would at present prices, cost 23 cents per tree for the season for materials alone. Using three gallons of paraffine oil in 97 gallons of bordeaux (2-2-100) as a late dormant treatment, and a summer application of nicotine, 1 pint in 100 gallons of bordeaux (2-40-100) the cost per tree for the season would be 11 cents.

SYSTEMS THAT LESSEN THE NUMBER OF TREATMENTS. There are two methods whereby the number of psylla treatments can be reduced; namely, (1) making the orchard unfavorable for the insect, and (2) use of lubricating oil emulsions.

As has been shown by Hartzell and Gambrell (2), the severity of pylla attack can be greatly reduced by modifying the environment. In fact, there are orchards in which psylla has never caused injury sufficient to demand remedial measures, while in near-by orchards the insect has been very destructive. Space forbids further discussion, but details will be found in the publication cited. From 1926 to the present time the writer has been investigating lubricating oil emulsions as regards their toxicity to psylla and their safety to trees under New York conditions, using mixtures containing three per cent of oil emulsified by means of bordeaux (2-2-100). During each of the four years (1926-1929) in some orchards these oil treatments, applied when the buds were swelling, protected the trees from this insect for the remainder of the season. During 1930 the psylla population was so light that a single application of oil or any of the standard sprays was sufficient to control the pest.

During no season was it necessary to add nicotine in the calyx spray, but in some instances a summer treatment with nicotine and bordeaux was required.

Unfortunately, dormant oil sprays when applied for several years in succession were found to injure weak trees. In several instances, during different years, injury occurred with the first application of oil, and in one case the trees did not appear to be exceptionally weak. In view of these results, at present in New York, it is not recommended that dormant sprays containing three per cent of oil be used on pears for more than two years in succession. It is suggested that if a grower desires to use such treatment that he omit it the third year and resume the practice for the following two years. This procedure is recommended only for vigorous trees. These statements refer to home-made lubricating oil emulsions. Commercial oil preparations should be used according to the recommendations of the manufacturers, with the understanding that the writer assumes no responsibility for any such recommendations.

CONCLUSIONS. The chief factors that reduce profits in pear growing in New York are pear blight, uncertainty in set of fruit, low prices, and pear psylla. Pear blight is a highly important factor because it is very destructive to the trees under certain conditions and, in order to decrease the loss, growers have been compelled to modify cultural practices to prevent succulent growth. Thru fear of this disease the vigor of the trees generally is kept somewhat below the standard necessary to prevent excessive damage, with the result that many weak trees are found; which condition is intimately related to spray injury.

Uncertainty in set of fruit is usually caused by failure to form fruit buds, by weak fruit buds, and by lack of pollination. The first two factors are largely a result of cultural methods made necessary to minimize loss from blight. Lack of pollination may be chiefly due to the failure of growers to provide sufficient trees that will cross-pollinate the commercial varieties, and also may result from unfavorable weather conditions.

The most potent cause of low prices appears to be the production of heavy crops of pears when there is an abundance of other fruit. This difficulty can be partially remedied by attention to pollination problems.

Pear psylla remains the most important insect pest of pears in New York and, in view of low profits, the maximum economy consistent with efficient control must be practised. Economy in control can be

secured by three means: (1) Reduction in amount of ingredients; (2) the use of cheaper materials; and (3) development of systems that lessen the number of treatments.

Experiments tend to show that the percentage of oil can be reduced and that, when used with bordeaux (2-40-100), the content of nicotine can be considerably lowered without decreasing the toxicity to pear psylla.

Pear orchards can be rendered unfavorable to pear psylla by modifying the environment, thus diminishing the number of treatments.

Use of lubricating oil emulsions effect economy by being cheap and at the same time reduce the number of treatments. Caution must be exercised in the use of these emulsions since they are toxic to weak trees, especially when applied for several years in succession.

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PRESIDENT FRANKLIN SHERMAN: The next paper is by C. L. Fluke, Jr., and T. C. Allen.

THE ROLE OF YEAST IN LIFE HISTORY STUDIES OF THE APPLE MAGGOT, *RHAGOLETIS POMONELLA* WALSH.

By C. L. FLUKE JR., and T. C. ALLEN, *University of Wisconsin*

ABSTRACT

Rearing of the apple maggot was readily secured by feeding the adult flies a simple solution consisting of one to three per cent yeast in five per cent honey water. The flies lived for many days, readily mating and ovipositing in small cages in the field or laboratory.

In making recommendations for the control of the apple maggot by spraying two important life history factors are involved, one of which is almost entirely dependent upon seasonal history studies. The use of yeast in feeding the adult flies has made it possible to make these determinations. The first factor which relates to the time of emergence of the flies from overwintering pupae is quite readily observed by the use of properly prepared wintering cages or by careful collecting of flies in the orchard to discover the first ones to emerge.

The second factor or preoviposition period is not so readily determined except by very careful rearing methods. Most investigators, ac-

cording to Porter (1928) have encountered serious difficulties in the study of many of the phases of the life history. He states that "the flies do not take readily to captivity, and only rarely can they be induced to lay eggs in insectary cages." Thus in beginning the studies of the apple maggot in Wisconsin every effort possible was made to discover a convenient technique in rearing the insect.

Our first supposition led us to believe that perhaps some kind of pollen might be necessary for the stimulation of life activities of the flies. With this in mind the first rearing cages were supplied with either squash pollen and water or water alone. All the flies were dead within ten days when fed water only; the addition of squash pollen prolonged life to a maximum of fifteen days. At this same time one cage was started in which the flies were fed honey water and in another series the cages were supplied a suspension of yeast in honey water. In these cages copulation was noted frequently and the life of a few of these flies was prolonged past 73 days. The maximum longevity in the cages containing only honey water was thirty-three days.

A few tests were also made with the waxy coating of the apples by first removing the coating and feeding it in a water suspension. This did not give very good results. One other cluster of flies was fed yeast in honey water for fifteen days and then placed on a diet of honey water without yeast but they continued to live only six more days.

The proportion which was finally used and which gave the best results was a one to three per cent yeast in five per cent honey water. Three hundred and six flies were fed in this manner with an average length of life of approximately thirty-two days, although many of them lived fifty and sixty days. The deaths of many of the flies were caused by accidents within cages such as being crushed by a loose apple, and by a few enemies which gained entrance to the cages in the field. Ants and certain mites were frequent annoyers in some of the cages.

It was very early discovered that regular daily feedings were necessary. An omission of one day in feeding often caused a high mortality. Many flies, however, which were nearly dead from apparent starvation, were completely revived by placing a drop of yeast and honey water on or near their proboscides. If they were able to feed they soon recovered.

The solution did not seem to attract them any great distance but if a droplet was placed within a few inches of a group of flies many would turn and commence feeding. As many as fifteen flies, the total number

in any one cage, were observed to feed at the same time. After feeding, a droplet of liquid would often appear on the proboscis of a fly; this droplet would then disappear, only to reappear a few moments later. This was repeated several times. Before starving flies were fed their abdomens were flat but after feeding they became greatly distended. Flies with a full abdomen would become more active, frequently side stepping and flipping their wings.

With the discovery of a good feeding medium it was necessary to construct cages suitable for use in the orchard. The one used most was made of a cylinder of screen wire, about 8 inches long and 4 inches in diameter. Each end was open but with a piece of muslin sewed on which would allow slipping the cage over a twig containing foliage. The muslin ends were then tied to the branch. In the lower side of the cage was fastened a small wire basket, just large enough to hold a small vial to contain the feeding solution. In this vial was placed a narrow strip of blotter which acted as a wick and gave the flies ample space on which to alight and feed. The vials were filled and the blotters soaked with the aid of a medicine dropper. The vials were replenished daily but a new wick was inserted and the vial cleaned every other day through a separate opening on the lower side of the cage.

If the flies were particularly hungry they would not fly away but would walk up to the end of the dropper to feed. Flies free in the orchard could also be induced to feed from the dropper.

In the laboratory two types of cages were used. The first was a simple one consisting of a glass beaker with the top covered with cheesecloth and the vial and blotter of yeast and honey water resting on the bottom. The second type which was used in the insectary was a flower pot filled with soil and covered over with either a lamp chimney or wire screening. There seemed to be no perceptible advantage of one over the other. During oviposition studies, clean apples were added and removed at various intervals. This method gave excellent opportunities to study the mating, oviposition records, egg stages, larval development, and other factors in the life history of the apple maggot.

Yeast has been known for some time as an aid in the rearing of certain insects. Baumberger (1919) showed that *Drosophila* are unable to grow normally on sterile fruit but will develop to maturity with the addition of living yeast. Glaser (1924) reported upon the relation of microörganisms to the development and longevity of flies. He states that the larval stages of flies are dependent upon certain accessory growth

factors which must be ingested with the food and that these factors are obtained by the larvae from bacteria or yeasts, as well as from higher plant and animal tissues. He states further that microörganisms and their activities are not absolutely essential to the normal growth, development, and longevity of the flies investigated. Glaser (1927) also readily reared house fly larvae during the winter, by using fresh horse manure to which had been added a heavy suspension of yeast cells in water. Grady (1928) used yeast with milk, bread, and sugar with excellent results to feed adult house flies.

From the experiments reported upon in this paper it seems possible that the supplying of nitrogen through the presence of dead yeast cells, which are highly protein, may be the particular aid that apple maggot adults derive from the yeast and honey water solution although enzymes or vitamines might be the essential life activating substances. Experiments are now planned which it is hoped will determine the exact role yeast plays in the life of the apple maggot adults.

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PRESIDENT FRANKLIN SHERMAN: The next paper is by P. J. Chapman, A. B. Burrell and F. G. Mundinger.

APPLE MAGGOT INVESTIGATIONS IN 1930

By P. J. CHAPMAN, A. B. BURRELL and F. C. MUNDINGER, *Geneva, N. Y.*

(Paper not received in time for publication.)

MR. M. D. LEONARD: What substitutes were used for arsenate of lead?

MR. P. J. CHAPMAN: Copper carbonate, pyrite, and other materials of that type.

MR. M. D. LEONARD: In general how did they compare?

MR. P. J. CHAPMAN: The results were rather inconclusive.

PRESIDENT FRANKLIN SHERMAN: We will now hear the paper of R. L. Webster and Anthony Spuler.

TRENDS IN CODLING MOTH CONTROL IN THE PACIFIC NORTHWEST

By R. L. WEBSTER and ANTHONY SPULER, *Pullman, Wash.*

(Paper not received in time for publication.)

QUESTION: Which traps do you find the best?

MR. R. L. WEBSTER: The formula used is one-fourth of malt syrup, and two or three cakes of yeast to about 19 gallons of water.

MR. E. R. VAN LEEUWEN: I would like to ask who was the originator of the moth trap.

MR. R. L. WEBSTER: That is difficult to say. I have found one record indicating that something of the sort had been used in Australia in 1893.

MR. LEONARD HASEMAN: We have found that the peak of our breeding cage emergence preceded the peak of the catch at bait traps from five to seven days. Have you found the same thing in your work?

MR. R. L. WEBSTER: You have to allow some ten days in the spring for the eggs to hatch. A shorter time is sufficient with the second brood in the summer.

PRESIDENT FRANKLIN SHERMAN: We will now listen to a paper by C. R. Cutright.

SOME LABORATORY REACTIONS OF YOUNG CODLING MOTH LARVAE

By C. R. CUTRIGHT, *Agricultural Experiment Station, Wooster, Ohio*

ABSTRACT

Laboratory work with newly hatched codling moth larvae, *Carpocapsa pomonella*, shows that the increase of temperatures within seasonal ranges aids them in establishing themselves in apples.

The great amount of laboratory work that has recently been done with newly hatched larvae of *Carpocapsa pomonella* has produced at least one definite result, namely, that the range of variability among such experiments is exceeded only by the range in field experiments with the same insect. Therefore, the writer in presenting a certain amount of data on laboratory experiments is quite aware that upon repetition some variability may appear.

The unusual growing season that the apple industry experienced in 1930 has given rise to several questions of particular interest, among which the following is outstanding. Do high temperatures aid the young larvae in establishing themselves in the fruit? In an effort to answer

this question the following laboratory experiment was devised and executed during August of the past season. Eighty apples of the same variety were collected from a sprayed orchard and after being washed in dilute (2%) hydrochloric acid were divided into four lots of 20 each. On each lot was then placed 40 newly hatched larvae and 40 eggs approaching hatching. The groups were then placed in constant temperature cabinets. The record was taken only on those larvae that completed growth in the fruits and then left them to spin up. The temperatures used and results obtained are shown in Table 1.

TABLE 1. INFLUENCE OF TEMPERATURE ON CODLING MOTH ESTABLISHMENT AND DEVELOPMENT

	Cabinet			
	No. 1	No. 2	No. 3	No. 4
Number apples used	20	20	20	20
Number young larvae and eggs used	80	80	80	80
Temperature maintained	59° F.	68° F.	77° F.	86° F.
Mature larvae developing and leaving fruit to spin up	0	3	14	29

These results indicate that there is a direct correlation between temperature and the ability of the larvae to establish themselves. In the 59° F. cabinet no larvae entered the fruit while at 86° F. the fruit was literally covered with entrances. The correlation coefficient for these data is very high, being .9315 and the odds that the data are significant are 26.5 to 1.

The ability of the larvae to enter the fruit at different temperatures was further checked in the following experiment. One hundred and eight arsenic free apples were divided into lots of 36 each and sprayed with various materials as shown in Table 2. Six apples from each lot were then placed in each of three cabinets. Five newly hatched larvae were deposited on each apple, the larvae being distributed in rotation according to cabinet and material. Results are shown in Table 2.

TABLE 2. LARVAL ENTRANCES ON SPRAYED FRUIT HELD AT DIFFERENT TEMPERATURES

Spray Material	Temperatures		
	68° F.	77° F.	86° F.
Ars. of Lead—1¼ lbs.–50 gal	0	1	5
Ars. of Lead—1¼ lbs–50 gal Dry Lime Sulfur—2½ lbs.–50 gal	1	3	5
Ars. of Lead—1¼ lbs.–50 gal. Cal-Mo-Sul—2½ lbs.–50 gal	1	3	7
S.O.K.—¾%	4	10	11
Ars. of Lead—1¼ lbs.–50 gal Liquid Lime Sulfur—1–50	3	1	2
Ars. of Lead—1¼ lbs.–50 gal W.S.L.—½%	3	7	5
Totals	12	25	35

Statistical analysis of the above figures yield a correlation coefficient of .4884, which definitely denotes association and odds of 45.7 to 1 that the data are significant. It, therefore, appears that high temperatures are decidedly favorable to larvae entering the fruit, even though the latter is thoroughly coated with spray material.

Since normal summer temperatures frequently fall within the range used in the cabinets it would seem that seasons of high temperature are not only favorable to the rapid development and increasing numbers of generations of the insect but also directly aid the young larvae in entering and establishing themselves in the fruit.

MR. T. J. HEADLEE: Do you think that was due to the direct effect upon the larvae of the temperature or the effect of the larvae on the fruit at the point at which they entered, or both?

MR. C. R. CUTRIGHT: It was due directly to the effect on the larvae. We have conducted other experiments and made observations that indicate that it is the temperature that aided the larvae rather than any effect that the temperature produced upon the fruit.

MR. W. S. HOUGH: During the last four years we have done some work along this line. We have records on about five or six thousand larvae entering unsprayed apples. There is a direct correlation between the percentage of entrance and the temperature at the time the young larvae hatched. The effect is on the worm rather than on the fruit.

If the larva does not feed within two hours after it hatches, the average loss of weight is 12 per cent. That stimulates action, which, in turn, increases the percentage of live larvae.

PRESIDENT FRANKLIN SHERMAN: A paper will now be presented by H. E. Hodgkiss and D. E. Haley.

A STUDY OF ARSENICAL RESIDUES ON APPLES IN PENNSYLVANIA WITH RESPECT TO EFFICIENT SPRAYING PRACTICES, II[1]

By H. E. HODGKISS and D. E. HALEY, *The Pennsylvania State College, State College, Pa.*

ABSTRACT

The protection of apple fruits from attacks of second brood codling moth (*Carpocapsa pomonella* Linn.) require a definite procedure of spraying ending early in July. In order to ascertain the range of total arsenic on fruits at harvest the residues on samples of fruits from typical orchards were analyzed. The summer of 1930 was

[1]Approved by the Director of the Experiment Station as Technical Paper No. 516.

unusually dry and the codling moth increased tremendously. Good control of the insects was obtained. The analyses indicated that for the most part the total arsenic content was below the export tolerance. Handling of the fruits reduced the arsenical content appreciably.

The attention of apple growers in Pennsylvania has been attracted to the condition of the fruits at harvest due to residues either from spraying operations, or from other causes. A large proportion of the fruits are grown for local markets but in the lower Susquehanna and Potomac watersheds the bulk of the crop is packed for shipment. In these areas it is essential that the arsenic content in spray residues should be kept below the export tolerance of .01 grain per pound of apples.

An insect control program has been arranged with the intent to obtain a maximum control of the several insect species during the early growing season. It is aimed to eliminate the midsummer arsenical spray applications in the regions where fruit is grown for export. In other counties where, normally, rains are abundant the midsummer applications of an arsenical spray often times may be advisable.

This program was operated first in 1926 which happened to be a year of excess rainfall in Pennsylvania. At that time apple fruits were collected and analyzed for total arsenic content in the residues. None of the samples had a residue the arsenic content of which approached the export tolerance. The same system of apple spraying recommendations was followed in 1930. There was a minimum rainfall in May but the situation was somewhat alleviated in June although early in July weather indications pointed to a rather extended dry period. This later developed into a drought which, according to the U. S. Weather Bureau, Philadelphia, Pennsylvania was the most severe of any that had occurred during the preceding 43 years.

The last regular spray application was recommended for the period between July 10 and 15. Under normal conditions of rainfall and insect development, this period has ended between July 20 and August 1. Precipitation during July and August was subnormal for which reason it was considered advisable to collect apple samples and analyze the residues for total arsenic content. Samples which were representative of state wide conditions were collected in 100 orchards by the Department of Entomology Extension, the Pennsylvania State College. The analyses were made by the Department of Agricultural and Biological Chemistry under the direction of the junior author. The same method

of analysis was followed as mentioned in the previous paper[2] and the results may be compared directly with those obtained in 1926.

EFFECTS OF SPRAYING PROGRAM ON THE INSECTS. The usual protective sprays were applied including the application at the petal-fall. Later arsenical cover sprays were intended chiefly as controls against plum curculio and the codling moth. Under usual conditions of weather and rainfall it has been possible to secure a reasonable control of codling moth under conditions of average orchard spraying. In some years as many as six cover sprays have been used but in 1930 on account of the droughty conditions only five were advised. In 107 orchards where the sprays were timely, and thoroughly applied the percentage of damage from plum curculio was 2.1 per cent; from codling moth, 1.3 per cent. Records taken in 94 other orchards where spraying was not timely or where critical treatments were omitted indicated that damages from plum curculio averaged 12.8 per cent; and from codling moth 10.7 per cent. The final or mid-July application of lead arsenate was of the greatest importance in the area where abnormal conditions of temperature and rainfall resulted in increasing the seasonal activities of both codling moth and plum curculio. Many plantings in which the last spray was omitted exhibited injuries from second brood codling moth which were often as high as 31 per cent.

ARSENIC CONTENT OF THE SPRAY RESIDUES. Samples consisting of 24 apples each, were selected in the orchards and these samples represented maximum amounts of residues on the apples on the trees. A total of 100 orchards in 41 counties contributed samples for the analyses. A square of heavy paper was placed around each apple and the fruit carefully removed from the branch. Each sample was packed in a cardboard carton and sent to the laboratory. All fruits were collected from the lower branches, where the maximum amounts of visible residue were found on the fruit before it was handled. A second collection was made from the same orchards after the fruits had been prepared for marketing.

METHODS OF ANALYSIS. The different samples were weighed before treatment for the removal of arsenic, and the As_2O_3 calculated per pound of fruit.

The modified Gutzeit method was used and gave satisfactory results. In removing the total quantity of arsenic from the surface of the apples, care was taken to remove any residue from the stem, cavity and calyx

[2]Jour. Econ. Ent., Vol. 20, No. 4, August 1927.

of each apple, and the surface was thoroughly washed with 3 per cent HCl followed by water. The solution obtained was then made up to volume and an aliquot was taken for analysis.

All determinations were made under the same conditions as to length of time, temperature, acidity, amount and surface area of the zinc employed. The results obtained are given in Table 1.

TABLE 1. RECORDS OF THE ARSENICAL ANALYSES

Lot and No. of Samples		Date of Collection	No. of Cover Sprays	Amounts of As_2O_3 per lb. of Apples
1.	52	Sept. 2–Oct. 10	5	.000–.005
2.	16	Sept. 3–Sept. 29	5	.006–.008
3.	9	Sept. 4–Oct. 10	5	.009–.0095
4.	11	Sept. 3–Oct. 10	5	.01 –.0105
5.	5	Sept. 3–Sept. 24	5	.011–.0115
6.	2	Sept. 12–Sept. 25	5	.012–.0125
7.	2	Sept. 24–Oct. 8	5	.013–.0135
8.	1	Oct. 8	5	.014
9.	1	Sept. 25	5	.015
10.	1	Sept. 3	5	.02

These collections represented typical conditions throughout Pennsylvania. There were 77 samples which were below both the domestic and world tolerance. Eleven samples equalled or just exceeded the world tolerance. Eleven others equalled or were less than the domestic tolerance. One sample exceeded the domestic tolerance.

Some variations in the analyses were on account of local rains during September although the samples showing the maximum amounts of arsenic were from orchards where the spray coverage of the fruits was rather heavy. In these cases there were no washing rains from the time that the spray was applied until after the samples were taken.

RELATION OF ARSENIC CONTENT TO MINIMUM RAINFALL AND CODLING MOTH CONTROL. The more extensive commercial apple growing counties were the most affected by the dry conditions. In Adams County the precipitation during July and August amounted to 1.09 inches. According to the weather records of the Pennsylvania Bureau of Plant Industry at Chambersburg the precipitation during July and August was 1.53 inches. The totals of the normals for these counties in those months is 8.44 and 7.52 inches respectively. In September there was an increase in amounts of rain which was for Adams County, 2.53 inches; and for Franklin County, 1.19 inches. These rains were in a large degree drenching showers of somewhat short duration.

Apple samples were taken from 14 orchards where the spraying operations are ordinarily uniform in character and where the complete

schedule was followed. These represented typical conditions in each of the fruit growing sections of the area. The amounts of insect control were high and codling moth infestation at harvest averaged 1.7 per cent. For purposes of comparison 13 other orchards were examined where the July application was omitted. In these plantings the average losses from codling moth amounted to as much as 27.5 per cent. Three samples were taken in Adams County on September 3. The arsenic in the residue of each lot amounted to .006 grains per pound of apples. The other lot showed .0115 grains of arsenic per pound of apples. Comparative figures are given in Table 2.

TABLE 2. THE RELATION OF ARSENIC CONTENT TO TIME OF SPRAY APPLICATIONS AND TO RAINFALL

County	Lot	No. of Samples	No. Cover Sprays	Dates of Last Spray	Rainfall July 7–to Date of Sampling	Amounts AS_2O_3 per lb. of Apples
Adams....	1	2	5	July 7–15	2.04	.000–.005
Adams....	2	4	5	July 7–15	2.72	.006–.008
Adams....	3	2	5	July 7–15	2.72	.01 –.0105
Adams....	4	2	5	July 7–15	2.72	.011–.0115
Franklin..	1	4	5	July 7–15	1.09	.000–.005
Franklin..	2	1	5	July 7–15	1.09	.009–.0095
Franklin..	3	1	5	July 7–15	1.09	.01 –.0105
Franklin..	4	2	5	July 7–15	1.09	.011–.0115
Franklin..	5	1	5	July 7–15	1.09	.013

AMOUNTS OF ARSENIC AFTER HANDLING FRUIT. Samples of apples were collected from trees in orchards and from the pack after handling. One lot from the College orchard was handled in the ordinary manner. In comparison with a sample collected as previously stated this lot showed a reduction of .003 grain per pound of apples. On two lots of apples that were passed over brushes in commercial packing sheds the differences were less. In these instances the reduction in arsenic content was either total or .001 grain per pound of apples.

GENERAL CONSIDERATIONS. Comparisons of the analyses for 1926 and 1930 indicate that thoroughness in making the applications combined with a proper timing of the sprays permits the use of an economical and practical program without serious harm from arsenical residues even under the most extreme conditions.

Apple growers as a rule did not experience difficulties from the amounts of arsenic in spraying residues on the fruits. The residues were moderately heavy and this condition caused some apprehension. Weather conditions helped the situation appreciably and as the harvest advanced little trouble was experienced from either arsenic tolerances or excess residues.

MR. M. D. LEONARD: How many double sprays were applied?

MR. H. E. HODGKISS: Five sprays applied, including the petal spray. When the final spray was made this year between July 10 and July 15 the weather was very hot. In some years this spray has been applied as late as July 20.

PRESIDENT FRANKLIN SHERMAN: The next paper is by F. L. Campbell and Charles Lukens.

A RADIOACTIVE INDICATOR METHOD FOR ESTIMATING THE SOLUBILITY OF ACID LEAD ARSENATE WITHIN THE ALIMENTARY TRACT OF THE SILKWORM

By F. L. CAMPBELL and CHARLES LUKENS, *U. S. Bureau of Entomology, Takoma Park, Md.*

ABSTRACT

By the use of the radioactive indicator method the rate of evacuation of lead by the silkworm (*Bombyx mori* Linn.) was determined following the administration of a known dose of acid lead arsenate and of a known dose of basic lead arsenate. It was shown that at least 25 per cent of a moderate lethal dose of acid lead arsenate goes into solution within the gut of the silkworm during its survival period. Acid lead arsenate was found to be much more soluble than basic lead arsenate within the gut.

The experiments of Cook and McIndoo (3) and of Tietz (5) indicated that acid lead arsenate is highly toxic to certain mandibulate insects because it is comparatively soluble in the juices of the alimentary tract. Their results were obtained by the use of standard methods of analysis for arsenic.

The same sort of information might be obtained by analyses of lead instead of arsenic. During the last decade a radioactive indicator method for the determination of minute quantities of lead has been developed and applied in Europe. Since it is more sensitive than any known method for the determination of arsenic, it should yield more exact information on the fate of acid lead arsenate in the body of an insect.

The purpose of the present paper is to describe the writers' adaptation of the radioactive indicator method for estimating the solubility of acid lead arsenate within the alimentary tract of the silkworm. The results here given are preliminary, but it is believed that they are sufficient to demonstrate the effectiveness of the method.

METHOD. The indicator used in the present experiments was thorium B, a radioactive isotope of lead. It is a true indicator in the sense that

an unknown but extremely small quantity is mixed with a relatively large, known quantity of lead. Mixtures of thorium B and lead are inseparable because thorium B is chemically the same as lead. Consequently when a mixture of the arsenates of lead and thorium B is fed to an insect, thorium B will accompany lead wherever it goes in the body and the ratio of thorium B to lead will remain the same as in the original mixture, regardless of the reactions into which the arsenate may enter. The constancy of this ratio and the measurable radioactivity of the thorium B make it possible to determine the fraction of a dose of lead that has found its way into certain tissues or into the excrement. For example, suppose that a standard preparation identical with the dose taken by the insect and containing a known quantity of lead is found to have a certain radioactivity under an electroscope; and suppose that the ash of the excrement is one-half as active as the standard at the same time; then the excrement contains one-half as much lead as was fed to the insect.

The foregoing example is the simplest possible case. In practice the method and calculations are more complicated, but it is not possible to go into all details and precautions in the present paper. The work of Behrens (1) should be consulted for detailed information on the method and calculations. In a recent book Paneth (4) has given a general account of the use of radioactive indicators.

The radioactive indicator method as applied by the writers[1] is described briefly as follows: A measured volume of a solution of thorium B in dilute acetic acid was mixed in a small glass cell with a measured volume of a solution of lead acetate. An aliquot of the mixture was withdrawn to serve as the standard and was placed in a watch glass. A radioactive acid lead arsenate was precipitated in the remaining solution by the addition of a solution of potassium dihydrogen arsenate. By first adding an excess of ammonia to the solution of potassium dihydrogen arsenate, a radioactive basic lead arsenate could be precipitated. In either case the precipitate was washed repeatedly by decantation until the pH of of the supernatant liquid reached that of distilled water. The precipitate with a little water was then sucked into a capillary pipette and was immediately forced out upon a mulberry leaf disk (7/8 inch diam.) near its periphery and in a region free from the larger veins. The resulting drop on the leaf disk was usually about 3 mm. in diameter. The leaf

[1]The writers are indebted to Dr. L. F. Curtiss, Bureau of Standards, and Dr. A. K. Brewer, Fixed Nitrogen Research Laboratory, for physical advice, and to Mr. C. M. Smith, Bureau of Chemistry and Soils, for chemical advice.

disk bearing the drop was placed under an electroscope to determine the radioactivity of the precipitate. From this measurement and the measurement of the standard, the quantity of lead in the precipitate was calculated. By multiplying the quantity of lead by a factor for acid lead arsenate or basic lead arsenate, the dose of either compound on the leaf disk was calculated.

The drop on the leaf disk was dried before a fan, and another leaf disk smeared with starch paste was pressed upon it to form a sandwich. The sandwich was given to a fifth-instar silkworm which had been kept without food for two or three hours. When the entire dose was consumed, the silkworm was weighed and was placed with fresh foliage in an incubator at 26°C. The silkworm was observed continuously and the time of evacuation of each pellet of excrement was recorded. Each pellet was weighed immediately, crushed in a drop of water, and washed into a funnel containing a 7 cm. quantitative filter paper. The leaf particles on the filter paper were washed 5 times with 5 cc. of distilled water. The filter papers bearing the leaf particles were placed in 125 cc. Erlenmeyer flasks and the filtrates were evaporated nearly to dryness in similar flasks. The organic matter in the flasks was destroyed by heating it in a mixture of nitric and sulphuric acids. Both acids were driven off as completely as possible and the residue was washed out of the flasks with concentrated hydrochloric acid into 2-inch watch glasses. The hydrochloric acid was driven off on a water bath and the radioactivity of the residue on each watch glass was determined under the electroscope. At the end of the experiment the entire silkworm was ashed in the same way. The sum of the corrected radioactivity of the ash from the pellets and from the silkworm was called 100 per cent of the dose of lead.[2] The corrected radioactivity of the ash on each watch glass divided by this sum and multiplied by 100 represented the percentage of the total dose of lead in the part from which the ash was derived.

The foregoing procedure was carried out on 1 silkworm at a time, 2 days being required for the completion of a single experiment.

Results and Discussion. The results of the writers' best experiment with acid lead arsenate are herein described and discussed. A dose of 0.12 mg. of acid lead arsenate per gram of body weight was taken by a silkworm weighing 1.78 grams. After taking the dose it fed on fresh

[2]The assumption of 100 per cent recovery of the lead administered was not far from the truth. In the case of the results shown in Figure 1 for two silkworms, 94.7 per cent of the lead was recovered from the larva that received acid lead arsenate and 98.7 per cent from the larva that received basic lead arsenate.

foliage for about 15 minutes and then stopped feeding for 10 hours. During the first 3½ hours a pellet was voided every 15 or 20 minutes, then the period between the evacuation of pellets lengthened until 4 hours elapsed between the expulsion of one pellet and the next. Following the resumption of feeding, the pellets were again voided more frequently but the larva was weak and probably would have died during the second day. It was ashed at the end of 24 hours.

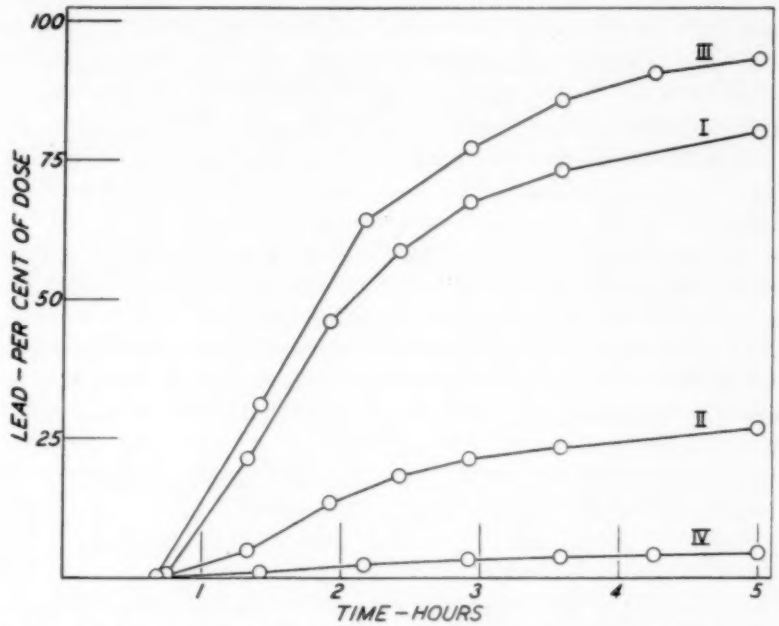

FIG. 1.—Rate of evacuation of lead by 2 silkworms following a dose of 0.12 mg. per gm. of acid lead arsenate in one case and of the same dose of basic lead arsenate in the other. Curve I shows the rate of evacuation of soluble plus insoluble lead from acid lead arsenate and curve III the same from basic lead arsenate. Curve II shows the rate of evacuation of soluble lead from acid lead arsenate and curve IV the same from basic lead arsenate.

The rate of evacuation of lead from the gut of this insect is shown by Curve I, Figure 1. It is a summation curve, the last point representing the sum of the percentages of soluble and insoluble lead in the 14 pellets voided during a period of five hours after the dose was taken. Each point adds to the preceding point the percentage of soluble and insoluble lead found in two pellets.

About half of the dose of lead was voided during the second hour. The rate of evacuation of lead then decreased gradually and at the end of 5

hours 80 per cent of the dose of lead had passed out of the insect. At the end of 24 hours (not shown in Figure 1) 97.6 per cent of the dose of lead had been voided by the insect, only 2.4 per cent remaining in the larva when it was ashed. This does not necessarily mean that 97.6 per cent of the dose of acid lead arsenate was voided in 24 hours because arsenic may have been eliminated more or less rapidly than lead following the decomposition of part of the acid lead arsenate in the gut. An attempt will be made later to determine arsenic and lead in the same pellets to throw light on this point.

The percentage of lead voided in the first few hours depends on the size of the dose. The larger the dose the sooner the insect is incapacitated and the fewer the number of pellets voided. For example, a silkworm that took a lethal dose of 0.22 mg. of acid lead arsenate per gm. voided only 25.6 per cent of the lead in four hours and died soon afterwards.

Cook and McIndoo (3 p. 47) noted the same relationship in terms of arsenic: "An analysis of 59 of the dead silkworms, each of which had eaten three drops of the arsenical [acid lead arsenate], gave 0. 0027 mg. of arsenic per larva, indicating that 90 per cent of the arsenic eaten had been voided in the feces before the larvae died. Silkworms which had received a maximum dosage of the same arsenical voided only 19 per cent of the arsenic eaten."

Whether the dose of acid lead arsenate is lethal or sublethal, a considerable part of the compound goes into solution in the gut. Curve II, Figure 1, shows that 27 per cent of the dose of lead was found in solution in the pellets at the end of 5 hours, which means that at least 27 per cent of the acid lead arsenate went into solution in that period.

An objection may be raised to this statement, for it is conceivable that some of the lead was put into solution by the relatively large quantity of water used to wash the pellets. This possibility was investigated in three different ways:

Radioactive acid lead arsenate containing a quantity of lead equivalent to that frequently found in a single pellet was pipetted directly upon the filter paper and washed in the usual way. Only 3.4 per cent of the lead was found in the filtrate, whereas the soluble lead in a single pellet usually ranged between 30 and 40 per cent.

Pellets from silkworms poisoned with acid lead arsenate always contain more liquid than those of normal larvae. The liquid can be seen on the surface of pellets from poisoned larvae. Some of this liquid may be obtained for examination without the use of wash water

by pressing the pellet with a blotter of filter paper. Six layers of filter paper were pressed against the fourth pellet from a poisoned larva. Spots of absorbed liquid were formed on the first five layers, the spot on the layer next to the pellet being, of course, the largest. The spots were cut out of the paper and ashed, the spot on the first layer being ashed in one flask and the spots on the next four in another. The dried pellet was ashed in a third flask. In the pellet 73 per cent of the lead was found; in the spot next to the pellet, 16 per cent; and in the four spots that did not come in contact with the pellet, 11 per cent. Therefore, at least 11 per cent of the lead was actually in solution in the pellet. Since most of the lead in the first layer of paper must have been in solution and since some of the lead in solution must have remained in the pellet, it follows that the results obtained by washing the pellets are not in serious error.

This conclusion was confirmed by a third test. It was reasoned that basic lead arsenate, which is known to be much less toxic to the silkworm than acid lead arsenate (Campbell and Filmer, 2, p. 530) should be decidedly less soluble in the gut than acid lead arsenate.

A dose of basic lead arsenate of about 0.12 mg. per gm. was fed to a silkworm weighing 1.58 grams. This larva was not affected by the dose and all the pellets were normal in appearance. The pellets were washed in the usual way. Curve IV, Figure 1, shows that only 4 per cent of the dose of lead was found in solution in the pellets that were voided during a period of 5 hours, although the total quantity of lead voided during that period was greater than that passed by the larva that took the same dose of acid lead arsenate (Curves I and III, Figure 1). The great difference in the percentage of soluble lead from acid lead arsenate and from basic lead arsenate not only confirms the results of the two preceding tests, but shows that acid lead arsenate is more toxic than basic lead arsenate probably because it is much more soluble within the gut.

The results of Cook and McIndoo in terms of arsenic (3, p. 45) do not indicate any difference between the solubility of acid lead arsenate and that of basic lead arsenate within the alimentary tract of the silkworm. They found in solution 28.7 per cent of arsenic from acid lead arsenate and 30.5 per cent of arsenic from basic lead arsenate. The percentage of soluble arsenic from basic lead arsenate is surprisingly high. Since Cook and McIndoo dried the pellets and gut contents at 105°C., the analysis should be repeated on fresh, unheated material.

To return to the present experiments, when it is considered that some of the lead in acid lead arsenate that went into solution was probably ad-

sorbed on the leaf particles in the pellets and could not be washed out and that some probably formed insoluble compounds in the gut, it is clear that any estimate of the solubility of a dose of acid lead arsenate by the method herein described is conservative. A true result could be obtained only by recovering and measuring the unchanged acid lead arsenate. The only conclusion that can be drawn from the present experiments is that at least 25 per cent of a moderate lethal dose of acid lead arsenate goes into solution in the alimentary tract of the silkworm during its survival period. In one case as much as 44 per cent of lead was found in solution in the pellets and in the gut of a silkworm at its death. The writers hope that further experiments will enable them to determine the relation between dosage and the percentage of acid lead arsenate that goes into solution and also to determine the distribution of lead in various tissues.

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Vice-President J. S. Houser assumed the Chair.

VICE-PRESIDENT J. S. HOUSER: We will now listen to a paper by R. L. Miller.

COPPER CARBONATE, ARSENATE OF LEAD AND OTHER COMPOUNDS USED AGAINST THE MEDITERRANEAN FRUIT FLY, *CERATITIS CAPITATA* WIED., ON CITRUS IN FLORIDA

By R. L. MILLER, *Orlando, Fla.*

(Paper not received in time for publication.)

VICE-PRESIDENT J. S. HOUSER: The next item on the program is a paper by Alfred Weed.

PROBLEMS IN THE MANUFACTURE OF LIQUID HOUSEHOLD INSECTICIDES OF THE PETROLEUM EXTRACT OF PYRETHRUM TYPE

By ALFRED WEED, *Entomologist, John Powell and Co., Inc., New York City, N. Y.*

ABSTRACT

The manufacturer of these products is confronted with a number of perplexing questions which include: the concentration of the toxic constituents to be used, the use of Pyrethrum powder or concentrated extracts in preparing his product, the selection of satisfactory petroleum fractions and perfumes.

The use of Pyrethrum as an insecticide has been very limited in the United States, although its toxic properties have been recognized for more than a century. Liquid petroleum extracts of Pyrethrum were first offered commercially in this country in 1917. Their principal development has been during the past seven years, during which time the imports of flowers have increased from approximately four million pounds in 1923 to from ten to twelve million pounds during each of the past four years, with a majority of this material entering into these products. Most of us are no doubt familiar with a number of these preparations as they have virtually world-wide distribution. It is general knowledge that an insecticide of this kind, properly used, gives reasonable control of a number of insect pests common to homes, institutions, and factories.

The manufacturers entering this industry are often seriously handicapped in their knowledge regarding the raw materials they use, and the methods by which they can achieve the highest degree of efficiency in manufacture. As a consequence, they are often dependent for this information upon the concerns who supply them with material. The use of a high grade Pyrethrum and a satisfactory oil are essential in the preparation of this insecticide. These, together with the use of a suitable perfuming agent are the principal problems which the manufacturer has to consider.

As the effectiveness of the finished insecticide is very largely dependent upon its content of the active principles of the drug, the importance of the quality of flowers employed cannot be over stressed. As there is no official method for the standardization of Insect Powder, material should be secured through selection based upon chemical or biological means for the evaluation of its toxicity. Today—just as in the past— Pyrethrum is sold under various trade designations. This grading depends upon the stage of maturity of the flowers and their geographical source, but it cannot be accepted as a criterion upon which the toxicity of the flowers resolve.

The manufacturer is offered Pyrethrum in two forms, either as the powder ground to varying degrees of fineness, or as a prepared extract of variable concentration. Grinding is in itself a most important process for excellent flowers can easily be destroyed by heat developed in the mill. The coarser material is extracted by percolation, while the finer grindings are restricted largely to extraction by agitation. The use of filter or hydraulic presses is frequently resorted to for a more complete removal of the liquid held back in the powder. Losses occurring through inefficient extraction is one of the major manufacturing difficulties. These insecticides are prepared using from five-tenths to two pounds of powder per gallon of solvent, although the usual commercial recommendation calls for one pound per gallon.

Concentrated extracts have facilitated considerably difficulties which the manufacturer is apt to encounter. Commercially these concentrates are designated in terms of powder in pounds extracted per gallon of solvent. The extracts of lower concentration are prepared by the method spoken of above, while the higher concentrates are made by a solvent recovery process. The use of these preparations does not give as complete control over the finished product, however, for one is forced to rely on the integrity of the concern supplying the extract.

Petroleum distillates lying within what may be termed the kerosene range, are the most widely used in the preparation of these insecticides. Other solvents have been investigated and are used, but kerosene is satisfactory as it extracts the toxic principles with a limited amount of inert matter and possesses a sufficiently high flash point to minimize the fire hazard. An acceptable grade of this fraction should be water white in color, possess a mild or sweet odor, and should be free from greasy residual matter. At the present time a number of oil companies distribute distillates which are known as "fly spray bases." These are special cuts, which are somewhat lighter than a majority of the ordinary kerosenes used for this purpose. The manufacturer should guard against the use of a distillate which is too volatile for such oils do not serve as satisfactory vehicles for Pyrethrum. On the other hand, it is not sound judgment to go the limit in the other direction for oils which are too heavy leave greasy smears which require many hours for complete volitalization.

As there is an odor which is characteristic of petroleum hydrocarbons, and which is considered by some to be objectionable it is desirable to mask it. For this purpose there are a wide variety of perfumes obtainable, selection of which rests with the manufacturer. Little information

is available regarding the effect which these materials have upon the toxicity of the finished product, but it is assumed that their presence in small quantities is not detrimental to the effectiveness of the insecticide. A suitable perfume for this purpose should possess volatile characteristics approximate to that of the oil with which it is to be blended. It is advisable to avoid a perfume which volatilizes too quickly leaving the unpleasant kerosene odor, but care should also be taken not to select a perfume which lingers after the kerosene is gone.

Manufacturing formulae include phenol, carbon tetrachloride, paradichlorobenzene and other materials, but the value of these additions to the finished insecticide is questionable.

MR. A. L. STRAND: Are the manufacturers of pyrethrum products buying their supply material strictly on the pyrethrum basis? Has that been accurately determined?

MR. ALFRED WEED: A controversy is going on at the present time in regard to the advisability of standardizing pyrethrum. It seems to be conceded that there is not enough statistical matter available at present based on chemical analyses to determine the most satisfactory method of assaying pyrethrum.

VICE-PRESIDENT J. S. HOUSER: The next item is a paper by H. G. Walker.

STUDIES ON THE USE OF EXTRACTS OF PYRETHRUM FLOWERS AS INSECTICIDES

By H. G. WALKER, *Columbus, Ohio*

(Withdrawn for publication elsewhere.)

VICE-PRESIDENT J. S. HOUSER: We will now listen to a paper by H. H. Richardson.

AN INSECTICIDAL METHOD FOR THE ESTIMATION OF KEROSENE EXTRACTS OF PYRETHRUM[1]

By HENRY H. RICHARDSON, *Investigator, Crop Protection Institute*

ABSTRACT

A method for evaluating pyrethrum extracts is described. It was found that different strengths of pyrethrum extracts vary directly in the speed with which they paralyze flies. A series of similarly performed tests indicated that the reproducibility of the results is great, especially the values for speed of paralytic action. The per-

[1]This investigation constitutes a part of the insecticidal research program of the Deep Rock Oil Corporation carried out under the supervision of the Crop Protection Institute at Iowa State College, Ames, Iowa, from July 1929 to Feb. 1930.

centage mortalities produced by such a series extended over a wider range but statistical analysis indicated that this variation was well within the limits of errors due to random sampling. Typical paralytic curves are shown and the value of the 50% paralytic point (the time when 50% of the insects are paralyzed) for making comparisons is pointed out. For a series of various concentrations of pyrethrum extracts the differences in mortality were not very great. This criterion of toxicity can only be used for diagnosing differences between extracts which differ widely in concentration. Differences in speed of paralytic action between a ¾ pound and a 1 pound extract of a fairly powerful grade of pyrethrum powder (0.26% Pyrethrin I) were easily distinguishable and were found to be clearly significant as indicated by statistical analysis. The differences in percentage mortality, analyzed similarly, were not significant.

The increasing importance of pyrethrum as an insecticide both in United States and foreign countries is beginning to be well recognized. In 1928 alone, 11,000,000 pounds of pyrethrum flowers were imported into the United States. This exceeded in value the total for all other imported insecticides and fungicides[2]. Such an occurrence has been happening regularly for the past decade. A large percentage of this pyrethrum, imported mainly from Japan, France and Dalmatia, is used for the preparation of household fly sprays which are compounded usually from kerosene extracts of pyrethrum.

The chemistry of the toxic principles found in pyrethrum has long presented a very difficult problem to organic chemists. In 1924, Staudinger and Ruzicka, two outstanding German chemists, started a series of publications on their researches which[3, 4, 5] solved to a large extent the chemical composition and structure of the active principles. Two esters, Pyrethrin I and Pyrethrin II were determined by them to be the toxic constituents. Recently Tattersfield, Hobson, and Gimingham, [6, 7] Gnadinger and Corl[8], as well as many others have made important contributions to the solution of the insecticidal properties of pyrethrum.

[2]Roark, R. C. JOUR. ECON. ENT. *22* (4): 699, (1929).

[3]Staudinger, H. and Ruzicka, L. (a) Helvetica Chim. Acta *7:* 177–259, (1924). (b) Helvetica Chim. Acta *7:* 377–90, (1924). (c) Helvetica Chim. Acta *7:* 406–58, (1924).

[4]Staudinger, H., Ruzicka, L. and Reuss, E. (Suomalaisen Tiedeakatemian) Ann. Acad. Scient. Fennicae A. *29* (17): (1927).

[5]Staudinger, H. and Harder, H. (Suomalaisen Tiedeakatemian) Ann. Acad. Scient. Fennicae A, *29* (18), (1927).

[6]Tattersfield, F., Hobson, R. P. and Gimingham, C. T. J. Agric. Science, *19* (2): 266, (1929).

[7]Tattersfield, F. and Hobson, R. P. J. Agric. Science, *19* (3): 433, (1929).

[8]Gnadinger, C. B. and Corl, C. S. (a) J. Am. Chem. Soc. *51:* 3054, (1929). (b) J. Am. Chem. Soc. *52:* 680–84; 684–88; 3300–3307, (1930).

In research for the development of a household spray it was necessary to devise a method for evaluating kerosene extracts of pyrethrum by the use of an insecticidal test. Peet and Grady[9] have published a method for testing household sprays which uses the percentage mortality after 24 hours as the main criterion for evaluating such a spray. O'Kane and co-workers[10] have described a different method for testing contact insecticides on flies and it, too, uses the percentage mortality as the main criterion of strength.

During this research it was found that various concentrations of kerosene extracts of pyrethrum vary directly in the speeds with which they paralyze insects. Some differences appeared in the final mortality produced by these extracts but for the usual concentrations found in household sprays, this value does not appear to be diagnostic. In the method herein described, both speed of paralytic action and percentage mortality data have been obtained. It can be said generally that greater strengths of pyrethrum extract act correspondingly faster in paralyzing flies. Significant differences (as judged by Fisher's method for the determination of the significance of a mean difference) were found for solutions differing in concentration as slightly as 0.000313 g. Pyrethrin I per cc. to 0.000237 g. Pyrethrin I per cc.[11]

DESCRIPTION OF THE APPARATUS. The apparatus (see plate No. 1) consists of the following:

(1) A rectangular box (2½ ft. x 2½ ft. x 4 ft.) with a glass top and sides; one side is built so that the glass can be moved back and forth.

(2) A copper wire screen cage (1½ ft. x 2½ ft. x 1½ ft.) which is placed on the inside of the box at one end (C in illustration). This cage is open on the bottom and its shape is such that it can be moved in and out of the box with ease. A piece of heavy brown wrapping paper is always placed underneath it when it is in the testing box. Actual tests have proven this paper to be of considerable importance since it adsorbs the oil droplets which fall during the test and thus prevents the flies from becoming entangled in the oil. Significant increases in mortality are produced if it is not used in the test. It is recommended that this paper be changed for each test though little difference has been noted if one paper is used for several tests.

[9]Peet, C. H. and Grady, A. G. J. ECON. ENT. *21* (4): 612, (1928).

[10]O'Kane, W. C., Westgate, W. A., Glover, L. C., and Lowry, P. R. New Hampshire Agr. Exp. Sta. Tech. Bull. 39, (1930).

[11]These concentrations correspond to those found in ¾ pound and 1 pound per gallon extracts of a fairly powerful pyrethrum powder. Pyrethrin I was determined by Tattersfield's short acid method. Pyrethrin II was not determined.

(3) The spraying device, (a No. 29 De Vibliss Atomizer), is located centrally on the outer side of one end (A). It is so placed that its nozzle projects into the testing chamber. The spray container, prepared from a graduated burette, is attached by a cork to the atomizer, and is graduated so that the amount of solution can be read to tenths of a cubic centimeter.

(4) A compressed air line is attached to the atomizer. This develops a constant five pound pressure by use of a Hoke Reducing Valve. (B).

(5) An electric fan situated at the end opposite the atomizer, is regulated to give a constant speed. (D). (A 9-in fan; 300-350 r.p.m.)

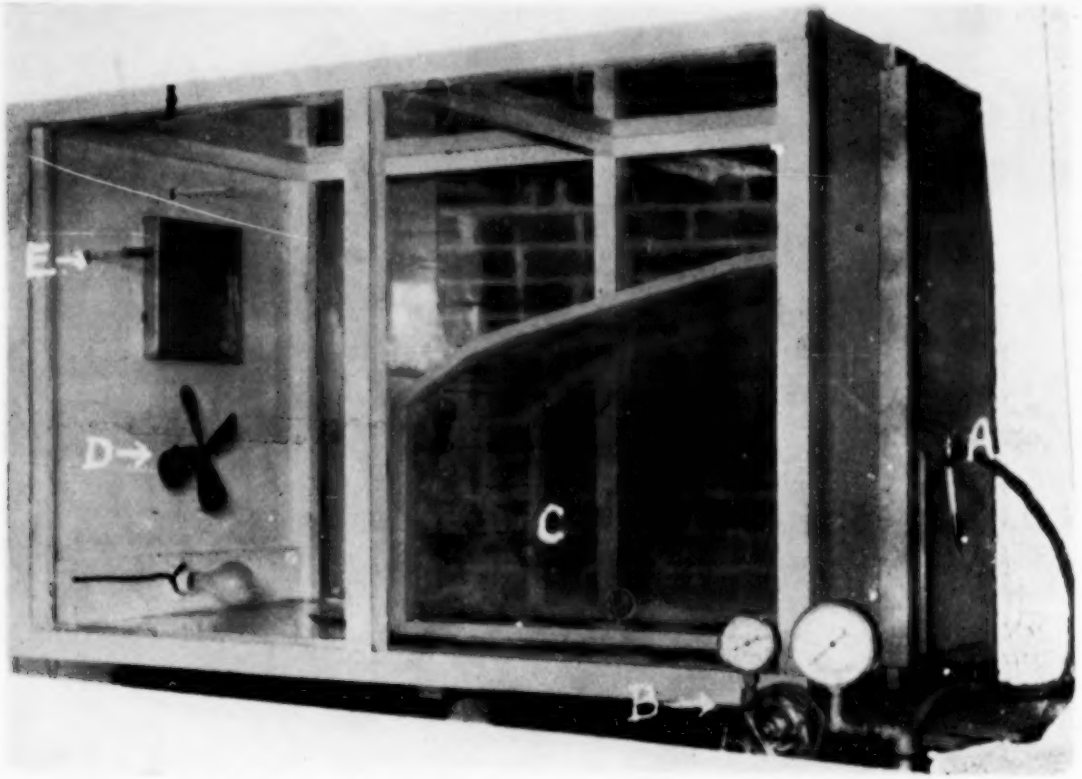
(6) A De Kotinsky temperature regulator, maintains a temperature of 83° F in the box. The temperature of the surrounding room is controlled roughly by means of radiators. (E).

PROCEDURE OF THE TEST. After airing out the test box, the wire screen cage is placed in position with the piece of heavy wrapping paper under it. Forty to sixty house flies of the same age (reared under constant conditions) are introduced into the wire screen cage through an opening in the side. The box is closed tightly and the fan is switched on. Upon opening the air line valve, the spray (1.6 cc.) is atomized into the cage where it is distributed by the air current from the fan.

At thirty second intervals, counts are made of the number of paralyzed flies (i. e. lying on their backs). These counts are continued until well over 50% of the flies are down. (All time measurements were made with stop watch.) The test is carried out for eight minutes after which even the weak pyrethrum extracts have paralyzed a majority of the flies. At the conclusion of the test, the box is opened and the screen cage is carefully removed. The flies are counted and then by means of the paper on which they lie, are transferred into a previously prepared cylindrical wire cage (8″ x 2½″).

Following this the testing box and screen cage are thoroughly wiped and aired out and the apparatus is ready for another experiment. Food (i. e. diluted milk soaked up by a piece of absorbent cotton) is placed at the disposal of the treated flies. After 24 hours, counts are made of the dead and live flies.

On one particular day the fly population appears to be non-differentiated and homogeneous, but it varies to some extent from day to day. This makes it necessary to carry out a complete series of tests each day. The same control solution is used for all series so that tests performed on different days are made comparable by use of the value for the control.



Insecticides testing apparatus, *A*, Atomizer; *B*, Air pressure regulating valve; *C*, Test cage; *D*, Fan; *E*, Temperature regulator.

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The speed of paralytic action is taken as the time when 50% of the flies are paralyzed. From the counts made at 30 second intervals and the total number counted at the end of the test, the 50% paralytic point can be easily calculated by interpolation. It has been found that this value varies directly with the strength of the kerosene-pyrethrum extract:—the stronger the extract the faster the paralyzing action.

TESTS FOR REPRODUCIBILITY OF RESULTS. To test the reproducibility of the results given by this method, a series of nine similar experiments were made; all with the same strength of pyrethrum extract,[12] performed under the same conditions with flies of the same age. The results of this series is given as follows:

TABLE 1. REPRODUCIBILITY TESTS—TOXICITY OF A PYRETHRUM EXTRACT TO HOUSE FLIES AT A CONCENTRATION OF 0.00089 G. PYRETHRIN I AND II PER CC. (SOLUTIONS USED AND CONDITIONS MAINTAINED WERE THE SAME FOR ALL TESTS)

Test Number	Number of Flies	50% Paralytic Point (in seconds)	Dead After 24 Hours Number	Dead After 24 Hours Per cent
1	47	81	7	15
2	42	75	6	14
3	50	78	9	18
4	39	77	4	10
5	38	78	5	13
6	55	79	11	20
7	43	77	6	14
8	45	80	7	16
9	64	81	8	12
Means		78.4″	–	14.89%
Stand. deviation of the observations		2.0″	–	2.86%
Percentage error of the observations		2.55%	–	19.2%
Stand. deviation of the mean		0.66″	–	0.99%
Percentage error of the mean		0.84%	–	6.7%

It can be seen from these data that the values for both the speed of paralytic action and the percentage mortality are quite reproducible. The standard deviation (from formula $\sigma = \sqrt{\frac{\Sigma d^2}{n-1}}$) indicates that the criteria for speed of action are especially uniform. The percentage of mortalities extends over a wider range. To determine whether this series

[12]Pyrethrum extracts were usually prepared by maceration of the powder in a percolator for several hours after which percolation was allowed to proceed at the rate of 10 to 20 drops per minute. With a fine grade of powder (200 mesh) no regulation was necessary as the powder packed closely and percolation proceeded slowly. In any one series of tests, all pyrethrum used was from the same, previously well mixed lot of powder.

was one which might be expected in the process of random sampling from a population in which the chance of death is constant, the data were tested statistically by the X^2 method,[13] using the form of computation devised by Snedecor[14], and especially adapted to the present situation in which the number of flies varies from test to test. For the percentage mortality data, $X^2 = 2.73$. This corresponds to a probability of 0.95 which indicates that such a series of percentage mortality data while unusually consistent is entirely possible under the chances of random sampling. This entire method will be described more completely in a subsequent paper. Figure 2 reproduces some typical curves

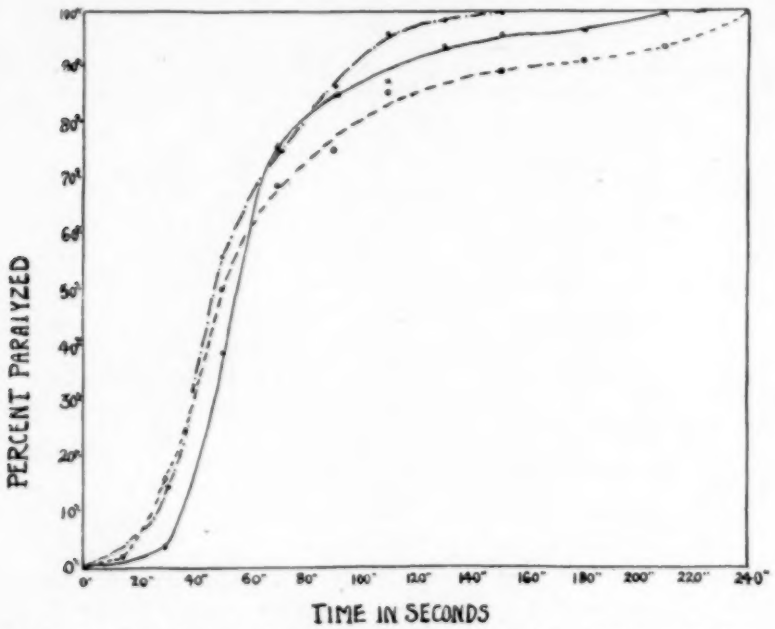

FIG. 2—Typical paralytic curves showing relationship of time with the percentage of paralyzed flies.

obtained showing the relationship of time and the percentage of paralyzed flies. The tests were all made with the same solution under constant conditions. A study of these curves gives an indication of the

[13]Fisher, R. A. Statistical Methods for Research Workers, 2nd. Edition, Oliver and Boyd; London (1928).

[14]Snedecor, G. W. The formula is as yet unpublished, but is in general use at Iowa State College. See Irwin in Genetics *14:* 344–345 (1929), and Proceedings of the Iowa Academy of Science, Volume 36 (in press).

variation to be expected at the different points in the paralytic curve. In these cases, the 100% paralytic point ranges from 150 to 240 seconds. The 50% paralytic point ranges from 48 to 55 seconds. These data substantiate the principle brought out by Fisher in a paper by Tattersfied and Morris[15] that the most accurate comparisons between various strengths of insecticides can be made when the concentrations are such that about 50% of the insects perish. This principle can be extended to the comparison of rates of paralytic action since both the rate of paralytic action and the percentage mortality are indications of the toxicity. In this research, comparisons between concentrations of pyrethrum extract were made exclusively at the 50% paralytic point.

TESTS WITH VARIOUS STRENGTHS OF PYRETHRUM EXTRACT. Figure 3 shows the results obtained in the study of a series of pyrethrum extracts varying in concentration from kerosene alone to a six pound to one gallon extract. The number beside each point gives the number of insects used in determining that value. The values represent the averages of a complete series of tests performed on ten different days. Approximately 500 flies were treated in investigating each solution with an average of 50 to 55 flies per test.

A study of this graph brings out the fact that the speed of paralytic action records very sensitively varying strengths of pyrethrum extract. The death curve, however, changes slowly over the range and can only be used for determining greatly different strengths of extract. For example, a three-fourths pound per gallon extract differs from a one pound per gallon extract in mortality, only 1%; in speed of paralytic action, 18 seconds. Such differences in speed of paralytic action are easily discerned. However, in mortality data a difference of 1% is insignificant.

In another experiment kerosene alone and kerosene-pyrethrum extracts of three-fourths pound and one pound per gallon strengths were tested in a series[16] carried out on nine different days (Pyrethrum showed 0.26% Pyrethrin I as analyzed by Tattersfield's short acid method). The average values for speed of paralytic action were: Kerosene—233 seconds, three-fourths pound extract—185 seconds, one pound extract—149 seconds. These differences were tested by Fisher's method[13] for the

[15]Tattersfield, F. and Morris, H. M. Bull. Ent. Research *14* (3): 223 (1924).

[16]Standard extracts were used. Such extracts were prepared by complete extraction of the weighed amount of pyrethrum with petroleum ether (40°–60° B. R.) in a Soxhlet extractor. The solvent was then evaporated with slight warming in a current of CO_2 and the residue was taken up in the proportionate amount of kerosene.

determination of the significance of a mean difference. In this method the speed of paralytic action for one solution on one day was subtracted from that of the other solution for that same day. Thus, ten daily differences were obtained and the mean and standard deviation of the mean were calculated. By the formula $T = \frac{Mx}{\sigma m}$ a value was arrived at which in turn was used in Fisher's table to find the probability. For the differences between a three-fourths pound and a one pound

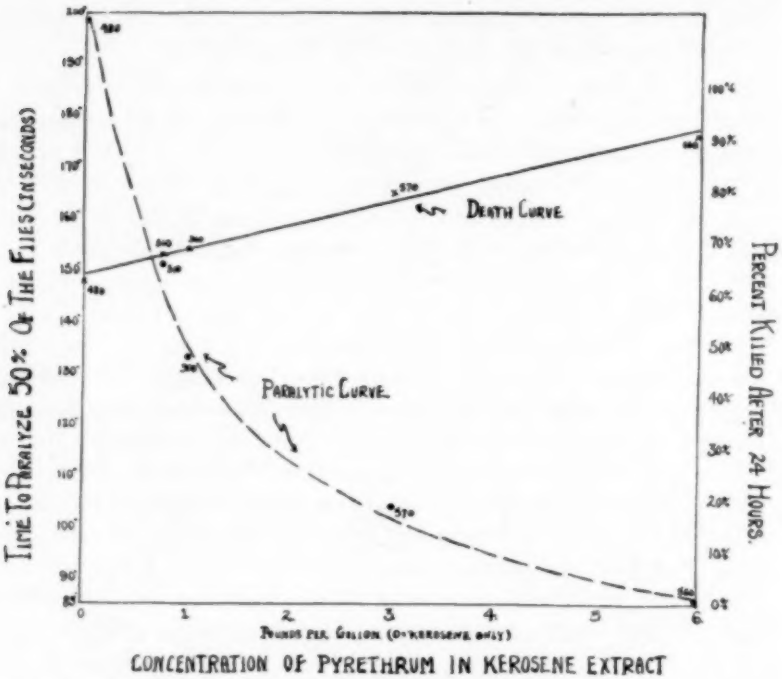
Time To Paralyze 50% Of The Flies (In Seconds)
Percent Killed After 24 Hours.
Death Curve
Paralytic Curve
Concentration Of Pyrethrum In Kerosene Extract

FIG. 3—Curves showing relation of pyrethrum extract concentration with time of paralytic action and per cent killed.

extract T = 12.06; for those between kerosene and a three-fourths pound extract, T = 9.22. Both of these T values give probabilities of less than 0.01. Such probabilities indicate that both differences are clearly significant.

By this same method, the differences in the percentage mortalities were investigated. T values were obtained which gave probabilities well above 0.05, thus indicating that the differences were not significant.

The author wishes to acknowledge his indebtedness to Dr. C. H. Richardson for his advice and criticism during the experiments; to Professor G. W. Snedecor, to whom all credit is due for suggestions as to the statistical methods for interpretation of the data.

This research has been directly sponsored by the Deep Rock Oil Corporation and their help aided greatly during the course of the experiments.

VICE-PRESIDENT J. S. HOUSER: We will now hear a paper by E. P. Felt and S. W. Bromley.

TESTS WITH NICOTINE ACTIVATORS

By E. P. FELT and S. W. BROMLEY, *Bartlett Tree Research Laboratories, Stamford, Conn.*

ABSTRACT

A series of field tests were conducted with nicotine in conjunction with the following—Penetrol, Sunoco Oil, Volck Oil, Commercial Soap Flakes, Sodium Oleate, Potassium Oleate and Kayso Calcium Caseinate. The insects involved were the Spruce Gall Aphid (*Adelges abietis* L.), the Black Cherry Aphid (*Myzus cerasi* Fabr.), the Spirea Aphid (*Aphis spiraecola* Patch), and certain brown aphids on conifers. The tests indicate the influence of a complex of factors on the results of the various sprays.

Since the appearance on the market in 1885 of "Gold Leaf Tobacco Extract," a forerunner of the Black Leaf 40 and Black Leaf 50 of the present, nicotine has been of increasing importance as a contact insecticide.

Despite the fact that each year brings forth new chemicals intended to supplant or at least supplement those in current use, nicotine still remains the outstanding contact insecticide for foliage applications.

The cost of nicotine has been the principal obstacle to its use. In large scale general spraying, the cost of nicotine is frequently the largest single item in the expenditures for spray materials. It may run from a quarter to a third of the total cost or even higher.

The development, therefore, of methods and means of increasing the effectiveness of the nicotine insecticidal unit charge, thereby allowing a decrease in amount used and consequently a lowering of cost, is being watched with a great deal of interest by all engaged in spraying practices.

The fact that most spray schedules call for the use of a contact spray in combination with an arsenical, demands that one of the first requisites of an additional material is compatibility with arsenate of lead.

The danger of serious foliage injury which exists where soaps and arsenate of lead are used together or where one is applied to foliage

bearing the residue of the other, precludes the use of soap in such a combination, particularly in regions where such injury frequently occurs.

Calcium caseinate (Kayso) in a mixture containing arsenate of lead and nicotine sulfate to make the normal amount of nicotine effective has been tried. Where there are arsenical residues on foliage, calcium caseinate and nicotine sulfate have also been used as separate contact sprays. That this is attended with danger is well known, since the amount of soluble arsenic formed when Kayso is mixed with acid arsenate of lead in the absence of hydrated lime and sulfur, is considerable (Ginsburg 1927).

Recent works by McGovran (1929) and Filmer (1930) have demonstrated the value of sodium oleate and potassium oleate soaps in reducing the interfacial tension between the spray solution and the integument of the insect, and also of the surface tension, to the point where the amount of nicotine may be considerably reduced and effective results still be obtained.

The development of penetrol as a nicotine activator has shown considerable promise. This material has been tested and reported upon by Hoerner (1929), Hartzell (1930) and Peairs and Gould (1930). Its promise at present seems to point to the possibility of its use on insect eggs or relatively inactive insects.

Bordeaux in a sense may be considered a nicotine activator, as the rate of liberation of the nicotine is increased when applied in combination with this mixture. It is a common observation in the field that the nicotine seems "stronger" when used with Bordeaux. This was brought out by Worthley (1927), who showed that both Bordeaux mixture and lime sulfur were good liberators of nicotine, and further that the efficiency of the nicotine was increased by the addition of sal soda.

The rate of liberation of the nicotine is an important factor and the use of a rapid or a slowly evolving spray should be governed by the type or stage of the insect to be controlled. Thus, a rapid evolution of nicotine should be more effective in controlling the more active insects and a slower evolution more effective in dealing with insect eggs.

In order to test some of these materials under actual field conditions in a comparative way, a series of experiments were conducted during the past season on several insects generally controlled by nicotine.

These tests are here reported under the heading of the insect, and while the limitations of the tests would not warrant sweeping generalizations from the figures obtained, they may at least be considered as indicative.

In most cases, a series of tests were conducted and standard spray materials were used as checks.

A. THE SPRUCE GALL APHID (*Adelges abietis* L.) A series of tests were conducted for the control of this insect on a row of infested Norway spruce trees averaging about 15 feet in height. The gall aphids at the time of spraying were in a partly grown, over-wintering condition, clustered on the undersides of the tips of the shoots. A check was made by counting the number of new galls appearing on the trees later in the season. The figures in this column indicate the average of the number of galls found on three trees, except the second case where the number of trees was two. No spray injury occurred on any of the trees. The applications were made on April 3, 1930.

TABLE 1. SPRUCE GALL APHID

Material	Temperature	Relative Humidity	Weather	Time of Application	Number New Galls July 29, 1930
Sunoco 1–50 ..... B. L. 40 1–800	43°F.	49%	Clear, calm	10:25 a.m.	None
Volck 1–50 ..... B. L. 40 1–800	—	—	Clear, calm	11:25 a.m.	None
Penetrol 1–200 B. L. 40 1–3200	49°F.	32%	Clear, calm	12:45 p.m.	32
Penetrol 1–200 .... B. L. 40 1–800	49°F.	37%	Cloudy	2:10 p.m.	2
Penetrol 1–200 .... Sunoco 1–66	49°F.	37%	Cloudy	3:10 p.m.	None
CHECK: UNTREATED					70 new galls

Under the temperature conditions here shown, it is evident that normal amounts of nicotine were necessary to obtain the best results. The reduced amount was quite apparently less effective. In fact, the value of the nicotine may be questioned under these conditions, as the heavier oils without nicotine gave control.

B. THE BLACK CHERRY APHID (*Myzus cerasi* Fabr.) A row of sweet cherry trees with an incipient infestation of this aphid, a few leaves near the trunk on the lower portions of the tree being curled, were sprayed with the materials indicated in the table. A check on the kill was made by examining a representative number of curled leaves and the live and dead aphids counted. No allowance was made for those which might have fallen from the tree in the interim. The first figure represents the average of two trees; the second, one tree; the third, three trees. The final examination was made six days after the application.

TABLE 2. BLACK CHERRY APHID

Date	Material	Temperature	Relative Humidity	Weather	Time of Application	% Kill
May 10	Soap Flakes (6 lbs.–100 gals., Kirkman's) B. L. 40 (1–800)	69°F.	28%	Clear, windy	11:10 a.m.	(Av. of 2 trees) 95%
May 13	Light Volck (1–66) B. L. 40 (1–800)	61°F.	68%	Cloudy, Light breeze	11:00 a.m.	(One tree) 99%
May 10	Penetrol (1–200) Nicotine (1–1600)	66°F.	32%	Clear, Light breeze	9:10 a.m.	(Av. of 3 trees) 45%

Even under these temperatures, which are higher than the last, but still under the temperatures best for the use of nicotine, the normal amount of nicotine appears to be necessary.

C. THE SPIREA APHID (*Aphis spiraecola* Patch). An opportunity was given of conducting experiments with a series of sprays on this insect. Both the spirea aphid and the foliage of the shrub were wetted with difficulty, this being no doubt one of the principal reasons for this aphid's resistance to spray.

The infested spirea were large shrubs and the aphid population occurring principally on the terminal growth was estimated as between 8,000–14,000 per shrub. The spray applications were made by means of a bucket pump.

The following materials were used.

Penetrol, a sulfonated oxidized product of petroleum, was supplied by the Kay Laboratories. The sodium oleate used was the material marketed under the name of "So-Fyne." The Potassium oleate was the Crystal Brand, C. P. O., containing 40% water. The Penethrum was a mixture of pyrethrum and penetrol, furnished by the Kay Laboratories. The arsenate of lead used was Grasselli's arsenate of lead paste.

No definite injury attributable to the sprays occurred, except possibly in the cases of the sprays marked by an asterisk. All the bushes began to show the effect of the drought by the middle of July, but these particular shrubs seemed to show a more reddened coloration of the leaves, although this was not extremely marked. The Penetrol, Nicotine, Kayso, arsenate of lead spray caused, however, serious burning, of the arsenical type, where applied on filbert.

The temperatures under which this series of tests were conducted were higher and within the optimum range for the use of nicotine. The kill here appeared to be distinctly correlated with the wetting properties of the spray, the best results being obtained with those showing the best wetting properties.

TABLE 3. SPIREA APHID

Date (1930)	Material	Temperature	Relative Humidity	Weather	Time of Application	% Kill	Remarks
June 17	Penetrol (1–200) B. L. 40 (1–3200)	74°F.	82%	Cloudy, rain	2:25 p.m.	Less than 50%	Poor wetting, evidently spray washed off by rain
une 19	Penetrol (1–200) B. L. 40 (1–3200)	77°F.	81%	Sunny, hazy	2:15 p.m.–4:00 p.m.	68%	Poor wetting
June 19	Penethrum (1–400)	77°F.	81%	Sunny, hazy	2:15 p.m.–4:00 p.m.	Less than 50%	Poor wetting
June 19	Sodium oleate (1–200) B. L. 40 (1–2400)	77°F.	81%	Sunny, hazy	2:15 p.m.–4:00 p.m.	100%	Excellent wetting
June 20	Potassium oleate (40% water—8 lbs.–100 gals.) B. L. 40 (1–4800)	75°–80°F.	70%–54%	Sunny, clear	10:00 a.m.–12 noon	100%	Excellent wetting
June 20	Red Arrow (1–2000) Red "A" Soap (1.5 oz.–1 gal.)	75°F.–80°F.	70%–54%	Sunny, clear	10:00 a.m.–12 noon	95%	Excellent wetting
June 20	Light Volck (1½%) B. L. 40 (1–3200)	75°–80°F.	70%–54%	Sunny, clear	10:00 a.m.–12 noon	99%	Spray hung in droplets at first, but eventually spread
June 20	Penethrum (1–200)	75°F-80°F.	70%–54%	Sunny, clear	10:00 a.m.–12 noon	50%	Poor wetting
June 20	Penetrol (1–200) *Kayso (4 lbs.–100 gals.) B. L. 40 1–3200 plus Ars. Lead 12 lbs.–100 gals.	80°F.	50%	Sunny, clear	1:30 p.m.	98%	Good wetting
June 25	Ars. lead 12 lbs.–100 gals *B. L. 40 1–800 Kayso 4 lbs.–100 gals.	86°F.	44%	Sunny, clear	3:15 p.m.	100%	Good wetting
June 25	B. L. 40 1–3200 Penetrol (1–200) Kayso (4 lbs.–100 gals.)	86°F.	44%	Sunny, clear	3:15 p.m.	100%	Good wetting
June 25	Penethrum (1–200) Kayso (4 lbs.–100 gals.)	86°F.	44%	Sunny, clear	3:15 p.m.	50%	Fairly good wetting
June 26	*Kayso (4 lbs.–100 gals.) Ars. of lead (12 lbs.–100) B. L. 40 (1–3200)	81°F.	50½%	Sunny, clear	11:45 a.m.	95%	Good wetting

D. Brown Aphids on Conifers. These aphids, evidently of different species, have not as yet been determined. They were, in each case, infesting small trees 4–6 feet high. Spraying was done by means of a bucket pump.

Table 4. Aphids on Conifers

Tree	Date	Material	Temp.	Relative Humidity	Weather	Time	% Kill	Remarks
Pinus parviflora	June 17	Penetrol 1–200 B.L. 40 1–3200	74°F.	82%	Cloudy	2:25 p.m.	99%	Good wetting
Pinus resinosa	July 7	Penetrol 1–200 Kayso 4 lbs.–100 gallons B.L. 40 1–3200	75°F.	82%	Clear	9:10 a.m.	100%	Good wetting
Picea excelsa	July 7	Penetrol 1–200 Kayso 4 lbs.–100 gallons B.L. 40 1–3200	75°F.	82%	Clear	9:10 a.m.	100%	Good wetting
Pinus strobus	June 2	Sodium oleate 1–200 B.L. 40 1–2400	75°F.	47%	Clear	1:25 p.m.	100%	Good wetting

The outstanding point here was the fact that a much better wetting of both foliage and insect was obtained on the species concerned with the penetrol-nicotine than that obtained on the spirea aphid with the same material.

The results that may be expected from the use of nicotine activators are, therefore, dependent on a complex of conditions, in which the type and stage of the insect, the type of the plant, the safety of the contact spray in relation to arsenate of lead, or to other sprays with which it may be used, the spreading and wetting qualities of the spray, the rapidity of the evolution of nicotine and the weather, temperature and humidity conditions are all factors.

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President Franklin Sherman resumed the Chair.

MR. C. R. CUTRIGHT: Do you know of any practical method of getting sodium oleate and potassium oleate into solution?

MR. S. W. BROMLEY: The sodium oleate we used was soluble; the potassium oleate was quite difficult to get into solution. The sodium oleate marketed under the trade name of Sofine goes into solution readily in water of the type that we used.

MR. T. J. HEADLEE: In using the crystal variety of potassium oleate we found that it had to be put in and stirred. It was simply a matter of stirring it a few times. There was perfect distribution.

PRESIDENT FRANKLIN SHERMAN: The next paper is by M. M. Darley.

SOME COMPARATIVE TESTS WITH ROTENONE, NICOTINE AND PYRETHRUM[1]

By MERRILL M. DARLEY, *Columbus, Ohio*

ABSTRACT

Rotenone at a concentration of 1:100,000, as a contact poison in spray form, was found to compare favorably in toxicity with nicotine at 1: 10,000 and pyrethrins at 1: 74,800, with "Penetrol" at the same concentration (1: 200) in each spray, in tests against the false cabbage aphid, *Rhopalosiphum pseudobrassicae*, in the field, and the spiraea aphid, *Aphis spiraecola*, in the laboratory.

Against adults of the spotted cucumber beetle, *Diabrotica duodecimpunctata*, and the Mexican bean beetle, *Epilachna corrupta*, pyrethrins at 1: 37,400 were effective, while nicotine at 1: 5,000 and rotenone at 1: 50,000 were ineffective, with "Penetrol" at 1: 100 in each spray. A rotenone concentration of 1: 1,000 (plus "Penetrol" 1: 200) was necessary before a mortality above 90% was secured with adults of *D. duodecimpunctata*.

Some preliminary tests with the common red spider, *Tetranychus telarius*, indicate that the relative toxicity of rotenone, as compared to the toxicity of nicotine and pyrethrins, to this pest, is appreciably greater than its relative toxicity as indicated in the aphid tests.

In the tests reported in this paper rotenone sprays were tested simultaneously, side-by-side with several standardized contact sprays based

[1]These tests were made at the Ohio State University, Columbus, Ohio, during the summer and early fall of 1930. The author is greatly indebted to Dr. Alvah Peterson for his helpful supervision.

on nicotine and pyrethrum. The tests were designed not only to yield data on the effectiveness of the several sprays but also to allow of an approximate comparison of the toxicity of rotenone and the toxicity of nicotine and pyrethrum. Dilutions of the following spray concentrates were used: "Black Leaf 40" (40% nicotine), "Nicotrol" (one part 40% nicotine to 19 parts "Penetrol"). "Penethrum" (equivalent of 2.85 pounds of pyrethrum flowers having a pyrethrin content of .75% plus sufficient "Penetrol" to make a gallon), "No. 520" (12 pounds of pyrethrum flowers plus "Penetrol" to make a gallon), "No. 519" (.2 gram of rotenone to 5 cc. of benzol and 95 cc. of "Penetrol"), and "No. 525" (a solution of rotenone, 1 gram in 50 cc. of acetone).

"Penetrol," a versatile standardized preparation consisting of sulfonated oxidized petroleum hydrocarbons, formed a part of most of the spray concentrates, as a carrier and spreader (and, in the case of nicotine, as an activator). Its use was also indicated with the "No. 525" concentrate, in preference to soap.[2] "Black Leaf 40" was used only with water, as a standard for comparison.

The main tests were made with the false cabbage aphid, *Rhopalosiphum pseudobrassicae*, in the field, and the spiraea aphid, *Aphis spiraecola*, in the laboratory. Additional tests were made with a number of other insects under laboratory conditions.

METHODS. In the case of *Aphis spiraecola*, infested sprigs of *Spiraea* sp. were placed in small bottles filled with water. The bottles were plugged at the neck with cotton and a circular paper collar fitted to the sprig just above the neck of the bottle to prevent aphids falling from the sprig from landing in the cotton plug and so becoming lost. After the sprigs were sprayed, the bottles holding them were placed within 8-inch circles of tree tanglefoot. Aphids found in the tanglefoot were counted as living. The same method was employed with the cone flower aphid, *Macrosiphum rudbeckiae*, on golden rod; the common red spider, *Tetranychus telarius*, on greenhouse cucumber; and a mealy bug, *Pseudococcus* sp., on parrot's feather (Myriophyllum).

Tests with *Rhopalosiphum pseudobrassicae* were made in the field. The aphids on a series of infested leaves of young cabbage plants were counted, each leaf tagged with an identification number and immediately sprayed. Only living aphids left on the leaves were counted as living.

Adults of the spotted cucumber beetle, *Diabrotica duodecimpunctata*, and the Mexican bean beetle, *Epilachna corrupta*, and nymphs of the

[2]Both rotenone and the pyrethrins are known to be subject to deterioration in alkaline mixtures.

squash bug, *Anasa tristis*, were placed in small wire screen cages, sprayed, the excess spray shaken off the cage, and an ample supply of food placed in each cage.

All the spraying was done with a small hand continuous sprayer delivering the spray as a fine, driving mist. A single, generous application of spray was made in each case and particular care was taken to secure a thorough application.

TESTS. Table 1 gives the spray specifications and final mortality figures for tests with two species of aphids. Since each spray was run in triplicate in each test, the mortality figures are actually the weighted means of a number of mortality values three times the number of tests conducted. That is, where six tests with one spray were run on a single species, the final mortality figure is the weighted mean of eighteen values secured from eighteen separate lots of the insect.

TABLE 1. ROTENONE, NICOTINE AND PYRETHRUM SPRAYS AGAINST APHIDS

Item No.	Concentrate and Dilution	Concentration[1] Poison	Penetrol	*Rhopalosiphum pseudobrassicae* Tests No.	Total Aphids	% Dead 48 hrs.	*Aphis spiraecola* Tests No.	Total Aphids	% Dead 48 hrs.
1	"Black Leaf 40" 1:1,000	Nicotine 1:2,500	None	(6)	2,989	97.0	(6)	2,812	90.7
2	"Nicotrol" 1:200	Nicotine 1:10,000	1:200	(6)	3,046	99.5	(6)	2,572	99.4
3	"Penethrum" 1:200	Pyrethrins 1:74,800	1:200	(6)	3,358	99.6	(6)	2,116	99.4
4	"No. 519" 1:200	Rotenone 1:100,000	1:200	(6)	2,500	98.5	(6)	2,776	97.3
5	"No. 520" 1:800	Pyrethrins 1:71,088	1:800	(6)	2,782	99.2	(2)	705	94.5
6	"No. 520" 1:1,000	Pyrethrins 1:88,860	1:1,000	(2)	499	92.4	—	—	—
7	"No. 519" 1:300	Rotenone 1:150,000	1:300	(2)	371	97.3	—	—	—
8	"No. 519" 1:400	Rotenone 1:200,000	1:400	(2)	306	79.7	(2)	955	81.0
9	"No. 525" 1:2000	Rotenone 1:100,000	1:200	—	—	—	(2)	940	100.0
10	Checks	No treatment	—	(6)	2,620	19.1	(6)	2,452	6.5

[1]These columns give the proportions resulting in the mixed spray from the dilution of the concentrate as given in the column headed "concentrate and dilution."

As can be seen in the table, rotenone at a concentration of 1: 100,000 (items 4 and 9) compares favorably in effectiveness with nicotine at 1: 10,000 (item 2) and pyrethrins at 1: 74,800 (item 3), with rotenone at only one-tenth (.1) the concentration of nicotine in the former and at seven hundred forty-eight thousandths (.748) the concentration of pyrethrins in the latter, and with "Penetrol" at the same concentration

(1:200) in each spray. Rotenone at 1: 150,000 (item 7) produced a kill in excess of that produced by pyrethrins at 1: 88,860 (item 6), with rotenone at only five hundred ninety-two thousandths (.592) the concentration of the pyrethrins. In this case, however, the concentration of "Penetrol" in the latter spray was only three-tenths (.3) its concentration in the former, which probably partially accounts for the difference in results.

An entirely accurate comparison of the results obtained perhaps can not be made since the mortality percentages, in most of the cases, are so near one hundred per cent as to leave scant latitude for significant variation.[3]

The superiority of pyrethrum sprays for use against larger, more resistant insects was demonstrated in the tests with adult beetles. Of the first five sprays listed in Table 1, only the two based on pyrethrins were at all effective at those concentrations. When the concentration (of both poisonous constituent and "Penetrol") of each of these sprays was doubled, the two pyrethrum sprays gave kills of 98%, while none of the kills produced by double concentrations of the other sprays exceeded 35%. The check mortality was less than one per cent.

TABLE 2. ROTENONE SPRAYS[1] AGAINST *Diabrotica duodecimpunctata* ADULTS

Item No.	"No. 525" Concentr.	Rotenone[2] Concentr.	No. of Tests	No. of Beetles	Per cent Dead in 24 hrs.	48 hrs.	72 hrs.
1	1:1,000	1:50,000	2	60	0.0	0.0	1.7
2	1:800	1:40,000	1	41	0.0	0.0	2.4
3	1:600	1:30,000	1	40	0.0	0.0	0.0
4	1:500	1:25,000	1	16	0.0	0.0	6.3
5	1:400	1:20,000	1	40	0.0	2.5	2.5
6	1:200	1:10,000	2	60	15.0	16.7	20.0
7	1:160	1:8,000	2	61	8.2	29.5	32.8
8	1:120	1:6,000	2	58	8.6	39.7	43.1
9	1:80	1:4,000	2	60	18.3	36.7	43.3
10	1:40	1:2,000	2	62	41.9	62.9	62.9
11	1:20	1:1,000	2	62	50.0	79.0	91.9
12	Checks	———	2	61	0.0	0.0	0.0

[1]"Penetrol" was added to each spray at the rate of 1:200.

[2]This column gives the concentration of rotenone resulting in the mixed spray from the dilution of the "No. 525" concentrate as given in the column headed "No. 525" concentration."

Table 2 contains data secured in tests against one of the larger, more resistant species, *Diabrotica duodecimpunctata*, with sprays having much higher concentrations of rotenone, with the "Penetrol" concentration

[3]A few preliminary tests with the cone flower aphid, *Macrosiphum rudbeckiae*. gave the following results: "Black Leaf 40" at 1: 1,000 (nicotine 1: 2,500) produced a mortality of 56.0%; "Nicotrol" at 1: 200 (nicotine 1: 10,000), 97.9%; "Penethrum" at 1: 200 (pyrethrins 1: 74,800), 80.0%; "No. 519" at 1: 200 (rotenone 1: 100,000). 96.9%. The check mortality was 23.2%.

(1: 200) held constant. A mortality above ninety per cent was secured with this insect only with a concentration of rotenone (1: 1,000) one hundred times greater than the concentration (1: 100,000) that produced an appreciably higher mortality in the aphid tests. This would indicate that rotenone sprays will probably prove to be much more suited to use against the smaller, more susceptible forms than against the larger, more resistant forms.

Only the pyrethrum sprays (items 3 and 5, Table 1), at from double to quadruple their concentrations given in Table 1, were appreciably effective against nymphs of *Anasa tristis*. A mealy bug, *Pseudococcus sp.*, was entirely unaffected by a single application of the several sprays tested against it (items 1, 2, 3 and 4, Table 1).

Some preliminary tests with the common red spider, *Tetranychus telarius*, indicate great promise for rotenone in combination with "Penetrol" against this pest. A series of tests, run in triplicate, in which 3,065 red spiders were used, gave the following results, with a single application of spray, after 24 hours: "Black Leaf 40" at 1: 1,000 (nicotine 1: 2,500) gave a mortality of 17.8%; "Nicotrol" at 1: 200 (nicotine 1: 10,000), 48.2%; "Penethrum" at 1: 200 (pyrethrins 1: 74,800), 22.7%; "No. 519" at 1: 200 (rotenone 1: 100,000), 75.0%; "No. 519" at 1: 100 (rotenone 1: 50,000), 89.8%. The check mortality was 6.4%.

These tests indicate that the relative toxicity of rotenone, as compared to the toxicity of nicotine and pyrethrins, to this pest, is appreciably greater than its relative toxicity as indicated in the aphid tests. Probably rotenone has some toxic property which may prove to particularly suit it for use against *Tetranychus telarius*, and other Acarina as well.

PRESIDENT FRANKLIN SHERMAN: I will now call for the paper by A. G. Ruggles.

PRELIMINARY NOTES ON THE BIOLOGY AND CONTROL OF THE PINE LEAF SCALE, *CHIONASPIS PINIFOLIAE* FITCH[1]

By A. G. RUGGLES, *University of Minnesota*

For several years the pine leaf scale, *C. pinifoliae*, has been increasing in abundance and importance as a pest in Minnesota, particularly in nurseries and on ornamental plantings. This scale is found well distributed over the state even in the natural forest. It has, however, never done notable damage under forest conditions. Whether this is due to

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parasites alone or whether some other natural control enters into the situation has not been determined.

When this insect first began to give trouble it was thought to be not at all serious. It was suggested that the ordinary spraying with nicotine and soap at hatching time would easily control the situation. Complaints, however, began to be more common and a survey of the situation was made. There appeared to be justification for these complaints, therefore experiments on control were begun, first using the formulae that had been recommended. In 1926 reports on some preliminary work showed a 90% control with nicotine and soap. The following year, however, the trees were as badly infested as before. It was not realized that in this locality there were two generations and the second one coming after our spraying program was over allowed the insects to spread at will. More experimental work was done in 1927 and in 1928. In 1928 very careful work was done comparing the control given by the Volck and nicotine sprays. The results showed that when carefully and thoroughly applied during the hatching season the scales could be kept under control. In spite of these results there was some dissatisfaction among the growers about the control they were getting and it was thought that better spraying compounds could be devised. Having these things in mind a careful study was again given to the problem in 1930.

The most badly infested areas were near the Twin Cities (St. Paul and Minneapolis), Lake City and Faribault. Experiments were planned particularly with the object in view of applying the spray in the midst of the hatching season. The eggs began to hatch at Lake City May 6th and at St. Paul May 10th. At Faribault which is 60 miles south of St. Paul and about the same latitude as Lake City, eggs did not begin to hatch until June 3. This did not seem reasonable, hence close observations were made throughout the season on the life history of the insect at as many places as could be reached conveniently by automobile. Observations for the season yield the following notes: At Lake City, eggs were hatching until well into June. At Faribault, eggs were hatching until well into July. At Lake City, males were first seen the middle of June. Males were also taken at Fairmont on this date. At Faribault the first males were not taken until July 10. At Lake City new females were laying eggs July 12 and some eggs were found hatching July 14. Males were taken August 1 and females with eggs were seen August 22. Egg laying did not begin here until well into September. At Faribault it was not until August 10 that females could be found with eggs in their bodies, and egg laying did not commence until well into

September. Further observations show that the insect seems to have two generations per season at St. Paul, Lake City, Fairmont and Austin, while at Faribault, Kenyon, Owatonna, Lake Itasca and Cass Lake, there is only one generation.

Just what factor or set of factors that produces one generation or two generations is an interesting problem. If it is known that there are not two strains or races, one tangible factor in these two towns (Lake City and Faribault) so closely situated is the one of length of season. The average date of the last killing frost in spring at Lake City and St. Paul is April 30, that of Faribault is May 10. The average date of the first killing frost in the fall at Lake City is October 5, while that of Faribault is September 30th. This would give on the average a fifteen-day longer growing season at one place than the other. Is this sufficient to account for the phenomenon? R. W. Dawson in his unpublished doctor's thesis and in an article in press at the present time in the Journal of Experimental Zoology has concluded that when development is in progress during the ascending temperature progression of the season, the development of a second generation commonly follows. Conversely, when development encounters the autumnal temperature decline, dormancy is frequently induced even though the actual temperatures are relatively high and the descending temperature scale short.

Two factors may be operative in causing a particular generation either to escape or encounter the autumnal temperature decline. These are the dates of beginning activity in the spring and the actual temperature levels of the season as it progresses, accelerating development if relatively higher and retarding development if relatively lower. This is a very fascinating theory and it has every appearance of being sound. Dr. Dawson's studies were made with *Telea polyphemus* Cramer.

In the fall of 1929 there were obtained for certain experimental purposes from a nursery, a number of white spruce, 6–8 inches high. These little trees were set in pots and placed in a greenhouse. In March, 1930, after the trees were of no further use in the original experiment they were treated with different spraying compounds in order to test the resistance of the needles to spray injury. At this time the buds on the trees were just breaking. One of the sprays used was liquid lime sulphur 1–7. Contrary to expectation this spray did not injure the needles in the least. A later application on the tender foliage gave the same result. Experiments to test the use of Lime Sulphur Spray on evergreens were accordingly planned for the next outdoor growing season.

At Lake City on April 29 as the buds were breaking Lime Sulphur (1–7) was applied to 6 Mugho pines, 1–2 feet high. On May 5 Lime Sulphur (1–7) was sprayed on 10 white spruce, 4–5 feet high. On May 26, when the new needles were very tender, Lime Sulphur (1–7) was given to 10 more white spruce 1–5 feet high. The last of June several large Colorado blue spruce were treated with different strengths of Lime Sulphur. The middle of July, 7 rows of white spruce, 2–3 feet high, each row 3 rods long, were treated as follows: 1 row Lime Sulphur, 1–7, 1 row Lime Sulphur, 1–10, 1 row Lime Sulphur, 1–15, 1 row Lime Sulphur, 1–20, 1 row Lime Sulphur, 1–30, 1 row Lime Sulphur, 1–40, 1 row was left as check.

At Faribault on May 31, just as the buds were breaking, 6 Colorado blue spruce 30 feet high were sprayed with Lime Sulphur (1–7).

The other treated plots at Lake City and dates of spraying were as follows—these treatments were applied in the midst of the hatching season—White Rose oil 2%; Volck Light 2%; Volck Light 1% plus nicotine sulphate; and nicotine sulphate and soap. The notes for the season on the effect on the foliage and the control of the scale are as follows:—White Rose oil 2% emulsified with calcium caseinate showed considerable burn which seemed to disappear later in the season. Lime Sulphur (1–7) applied in July gave a slight burning but no ill effects were noticed later in the season. No injury was observed with the other strengths of lime sulphur or with Lime Sulphur 1–7 in months other than July, nor with the other oils. In every case with any of the sprays mentioned, except perhaps Lime Sulphur 1–40, where the spraying had been carefully done, the scales were thoroughly under control.

In the case of the Lime Sulphur and the first generation it was very interesting to watch the effect on the eggs. Many of the eggs remained turgid and seemingly healthy for weeks up to the time of collapse. In the case of the other sprays the effect on the eggs was more rapid. It is hoped that this phase of the subject can be studied as a special problem later.

In the literature on Pine leaf scale control, lime sulphur is often mentioned. Houser, Ohio Bulletin 332, gives a good account of its use. He says Lime Sulphur dormant strength was used against this scale with good results and without injury to the trees. He does not recommend it, however, because the test was not sufficiently comprehensive. These preliminary experiments reported upon here show that lime sulphur under ordinary conditions is not harmful to the foliage of evergreens. It is possible that the season had something to do with the results. Another season might tell a different story. Up to the present time, how-

ever, it appears that lime sulphur as a control for pine leaf scale on pines and spruce has been overlooked. Further investigations will be carried on this coming year.

MR. F. L. GAMBRELL: Do you spray if the residue affects the appearance of the foliage?

MR. A. G. RUGGLES: The lime sulphur held on for a considerable time but disappeared later in the season. We wish to follow this matter a little more closely. I was more interested in determining whether injury would result and did not pay so much attention to the appearance of the foliage.

MR. F. L. GAMBRELL: In our work on evergreens we have had the same experience as that reported by Mr. Ruggles. No injury has resulted from the use of lime sulphur, either to the new or old growth.

PRESIDENT FRANKLIN SHERMAN: The paper by R. H. Robinson will be read by F. H. Lathrop.

ORGANIC SOLVENTS FOR AIDING THE REMOVAL OF SPRAY RESIDUE FROM WAXY OR OIL-COVERED FRUIT

By R. H. ROBINSON, *Chemist, Oregon Agricultural Experiment Station*

ABSTRACT

Oil sprays and excessive wax formation on apples complicate the removal of spray residue. When certain organic solvents such as alcohol, benzol, acetone, kerosene, etc., are added to the hydrochloric acid washing solution the residue is removed more effectively. Kerosene seems to be the most practicable for the purpose.

Complications caused by the use of oil sprays and by the formation of natural wax on fruit, often prevent the removal of the spray residue below the required tolerance by the usual washing procedure. Generally the use of warm acid, maintained at a temperature of 100° to 110°F. by the introduction of live steam, is effective and most oil-covered or waxy fruits can be satisfactorily cleaned. The use of heat, however, necessitates additional equipment and expense so that the orchardist and fruit packer hesitate to make changes that further complicate the washing process. Instead they make a futile effort to wash the fruit below the tolerance by increasing the strength of the acid solution. In some cases both heating the acid solution and increasing the acid concentration as high as 2.0% has not been sufficiently effective to clean the fruit below the tolerance.

Waxy or oil-covered fruit is difficult to clean because the oil or wax coats the lead arsenate particles and protects them from the solvent

action of the acid. When warm acid is employed the protective coating is softened. Aided by the increased solvent action at higher temperatures, the warm acid more effectively dissolves the lead arsenate particles. It occurred to the writer that the use of some organic solvent mixed with the acid solution might dissolve enough of the wax or oily coating to permit contact between the acid and the lead arsenate particles. Effective cleaning would then be accomplished. While preliminary laboratory experiments were encouraging, it was quickly demonstrated that the number of chemicals that might prove practical was limited. Volatile compounds, such as benzol or gasoline, created a fire hazard. Compounds miscible with dilute hydrochloric acid, such as alcohol and acetone, did not seem to give immediate outstanding results. Emulsions of common organic solvents, such as benzine, carbon tetrachloride, benzol, gasoline, and kerosene, showed about equal promise. Since kerosene seems in every way most practical, particular attention was given to observations using this solvent.

The following preliminary laboratory experiments are cited to demonstrate the superior solvent action of acid and kerosene mixtures over acid alone when agitated with oil or wax-coated lead arsenate.

Lead hydrogen arsenate was treated with both oil and wax, care being taken to coat all particles as uniformly as possible. To do this one gram of a heavy lubricating oil was dissolved in 25 cc of petroleum ether. Ten grams of lead arsenate were then added and the mass stirred continually over a low heat until the ether was entirely driven off. The lead arsenate remained in powder form and well coated with oil. In like

TABLE 1. SOLUBILITY OF OIL-COATED LEAD ARSENATE IN SOLVENTS

Solvent	Concentration %	Lead Arsenate in 1 liter of Solvent After 5 min. gram.	After 10 min. gram.
Hydrochloric acid	.1	.482	.593
Hydrochloric acid Kerosene	.1 1.0	.550	.680
Hydrochloric acid Kerosene emulsion	.1 1.5	.150	.604

manner lead arsenate was coated with wax, extracted from waxy Spitzenberg apples. The solubility of the coated arsenicals in hydrochloric acid and in kerosene-hydrochloric acid mixtures was then determined. The procedure was as follows: Exactly 500 cc of the solvent was transferred to a liter bottle, adjusted to 20° C. and 2.5 grams of the coated lead arsenate were introduced. This mixture was agitated vigorously for 5 minutes in a mechanical shaking machine. About 200 cc was removed quickly and immediately filtered. 100 cc aliquots were then

taken and the amount of lead arsenate in the solution determined. Portions were taken also after 10 minutes shaking and the lead arsenate in solution was determined.

TABLE 2. SOLUBILITY OF WAX-COATED LEAD ARSENATE IN SOLVENTS

Solvent	Concentration	Lead Arsenate in 1 liter of Solvent After 5 min.	After 10 min.
	%	gram.	gram.
Hydrochloric acid	.1	.435	.540
Hydrochloric acid + Kerosene	.1 + 1.0	.505	.694
Hydrochloric acid + Kerosene emulsion	.1 + 1.5	.494	.655

Tables 1 and 2 show that the combined solvents dissolved larger amounts of the oil and wax-coated lead arsenate than did the acid alone.

EXPERIMENTAL TESTS WITH COMMERCIAL WASHING MACHINES. During the past two seasons many practical fruit washing tests with organic solvents have been observed. Both oil-sprayed and waxy fruit have been washed in various types of washing machines where mixed solvents have been used. A few series of these, chosen to illustrate best the effectiveness or otherwise of certain combined solvents, are reported and discussed below.

TABLE 3. CLEANING OF LEAD ARSENATE-OIL SPRAYED PEARS WITH MIXED SOLVENTS (BEAN JET MACHINE)

Solvent Combination	Arsenous Oxide Grain per lb.	Per cent Removed
Unwashed check	.048	—
Hydrochloric acid 0.4%	.028	41.6
Hydrochloric acid 0.4% + alcohol, denatured, 1.0%	.024	50.0
Hydrochloric acid 0.4% + acetone 1.0%	.021	56.2
Hydrochloric acid 0.4% + alcohol 1.0% + benzol 0.2%	.018	62.5
Hydrochloric acid 0.4% + alcohol 1.0% + benzol 0.2% + oil, pet. 0.2%	.031	35.5
Hydrochloric acid 0.4% + Kerosene emulsion 1.0%	.018	62.5
Hydrochloric acid 0.4% + Gasoline emulsion 1.0%	.025	47.9

In the first series a number of miscellaneous combinations of solvents were tested in order to learn whether, under practical conditions in a commercial washing machine, some combination would give outstanding results. Bartlett pears were used that had received five cover sprays of lead arsenate, in two of which an oil emulsion had been added. About three weeks only had intervened between the date of the last oil spray and harvest. The emulsions were prepared by emulsifying one gallon of oil with two quarts of water containing one pound of kaolin. The combined organic solvents, such as alcohol and benzol, was first mixed together and then added to the acid tank. A low concentration of acid was

maintained in order that increased cleaning effects attributed to the organic solvents would be more marked. A Bean, jet-type, washing machine was used. Table 3 shows the amount of arsenic as arsenous oxide remaining on the fruit after the washing treatments, and also the percentage actually removed based on the amount found on the unwashed check.

Most of the combined solvents cited in Table 3 showed better cleaning effects than did hydrochloric acid alone. However, differences are apparent that seem inconsistent. For example, there is no reason why the kerosene emulsion-acid mixture should clean the fruit better than the gasoline emulsion-acid combination. This may best be explained by assuming that abnormal variations occurred in the arsenical load carried by individual samples. While every effort was made to choose fruit evenly covered with spray, the amount of oil that protected the arsenical particles could not be discerned by visible inspection.

The orchard-run pears from which the experimental samples were chosen were cleaned effectively below the .01 tolerance by washing in 1% acid. In order to learn whether the strength of the acid in the kerosene emulsion-acid mixture could be reduced materially below 1.0 per cent and yet clean the fruit, it was adjusted at .73 per cent. Picked samples showing the heaviest load of spray and a box of orchard-run were put through the wash. The former cleaned well below the .01 tolerance, but a few spotted samples from the box showed above the tolerance.

In the next series of observations a Cutler-Moe flood-type washing machine was used for the test. Waxy Newtown apples, selected carefully for even distribution of spray over the entire apple, were used. All of the emulsions were prepared as specified above by adding Kaolin as the emulsifier. Since the Cutler-Moe washer circulated huge volumes of the washing acid through the machine, maintaining it in a continuous state of turbulent agitation, tests were included using straight kerosene and gasoline in addition to the emulsions.

Table 4 contains the results of this series.

The results in general again indicate better cleaning with the mixed solvents than with acid only. Kerosene and gasoline both dispersed well in the acid solution and removed more residue than the kerosene emulsion combination. Inconsistencies occurred as in the previous series which again suggests wide variation in individual samples. This was confirmed by analyses of the cleanest and most spotted fruit selected from the lot of apples washed with the kerosene-acid mixture as shown in the table.

TABLE 4. CLEANING OF WAXY APPLES WITH MIXED SOLVENTS (CUTLER-MOE, FLOOD-TYPE MACHINE)

Solvent Combination	Arsenous Oxide Grain per lb.	Per cent Removed
Unwashed check	.041	—
Hydrochloric acid 0.33%	.022	46.3
Hydrochloric acid 0.33% + alcohol (denatured) 1.0%	.018	56.0
Hydrochloric acid 0.33% + acetone 1.0%	.026	36.5
Hydrochloric acid 0.33% + benzol emulsion 1.0%	.014	65.8
Hydrochloric acid 0.33% + oil (vis. 55) emulsion 1.0%	.026	36.5
Hydrochloric acid 0.33% + Kerosene emulsion 1.0%	.020	51.2
Hydrochloric acid 0.33% + Kerosene 1.0% max.	.020	51.2
min.	.016	60.1
Hydrochloric acid 0.33% + Gasoline 1.0%	.018	56.1

In all of the foregoing tests both emulsified and straight kerosene, appeared to be as effective as any of the solvents studied. In order to know whether straight kerosene would be effective in a jet-type machine, where the mechanical agitation is not very great, the following series was undertaken. A Bean jet-type machine was used. Heavily sprayed Anjou pears and Newtown apples were selected for the test. These fruits had received four cover sprays with one application of a medium oil emulsion mixed with the arsenate of lead. Variations were made both in the strength of acid and the amount of kerosene mixed in the combinations. The results are tabulated in Table 5.

TABLE 5. EFFECTIVENESS OF HYDROCHLORIC ACID AND KEROSENE AS A COMBINATION SOLVENT FOR OIL-COATED RESIDUE (BEAN JET MACHINE)

Variety	Solvent	Arsenous Oxide Grain per lb.	Per cent Removed
Pears, Anjou	Unwashed check	.056	—
Pears, Anjou	Hydrochloric acid 0.33%	.034	39.2
Pears, Anjou	Hydrochloric acid 0.33% + kerosene 1.0%	.036	35.7
Pears, Anjou	Hydrochloric acid 0.66%	.035	37.4
Pears, Anjou	Hydrochloric acid 0.66% + kerosene 1.0%	.038	32.2
Pears, Anjou	Hydrochloric acid 0.66% + kerosene 2.0%	.035	37.4
Pears, Anjou	Hydrochloric acid 1.0%	.032	42.8
Pears, Anjou	Hydrochloric acid 1.0% + kerosene 2.0%	.029	48.2
Apples, Newtown	Unwashed check	.048	—
Apples, Newtown	Hydrochloric acid 0.33%	.027	43.8
Apples, Newtown	Hydrochloric acid 0.33% + kerosene 1.0%	.033	31.2
Apples, Newtown	Hydrochloric acid 0.66%	.021	56.3
Apples, Newtown	Hydrochloric acid 0.66% + kerosene 1.0%	.018	62.5
Apples, Newtown	Hydrochloric acid 0.66% + kerosene 2.0%	.013	72.9
Apples, Newtown	Hydrochloric acid 1.0%	.019	60.5
Apples, Newtown,	Hydrochloric acid 1.0% + kerosene 2.0%	.016	66.7

If judged from the results obtained by washing the Anjou pears, a straight kerosene-acid combination cleans no better than acid alone when used in a jet machine. The differences in the various analyses are within experimental error. Better results, however, were obtained with the apples. While not very marked, some positive results are evident

On the basis of these and similar results, it is not advisable to use kerosene in the jet-type washing machine to aid cleaning unless it is first emulsified.

The effectiveness of a straight kerosene-acid mixture was also studied particularly, when a flood-type machine was employed. In order to obtain more evenly sprayed fruit, a batch of Arkansas Black apples were prepared in the laboratory by spraying with a lead arsenate-oil emulsion combination. Double strength arsenate was used in a 6% oil emulsion, and care was exercised to cover the fruit as evenly as possible. In addition, a bad lot of carefully selected orchard-run Spitzenberg apples were washed with the same combination treatments. These apples had received five cover sprays with one oil spray in combination with the arsenate of lead, and had been harvested so late in the season that an excessive amount of wax had formed. Table 6 contains the results of this series.

TABLE 6. EFFECTIVENESS OF HYDROCHLORIC ACID AND KEROSENE AS A COMBINATION SOLVENT FOR WAXY AND OIL-COATED RESIDUE ON APPLES (CUTLER-MOE FLOOD-TYPE MACHINE)

Variety	Residue Coating	Solvent	Arsenous Oxide Grain per lb.	Per cent Removed
Ark. Black	oil	Unwashed check	.0410	—
Ark. Black	oil	Hydrochloric acid 0.60%	.0127	69.0
Ark. Black	oil	Hydrochloric acid 0.60%+Kerosene 1.0%	.0068	83.5
Ark. Black	oil	Hydrochloric acid 0.60%+Kerosene 2.0%	.0085	79.3
Ark. Black	oil	Hydrochloric acid 0.60%+ Kerosene 2.0%; fruit put through washing machine two times	.0038	90.7
Ark. Black	oil	Hydrochloric acid 0.94%+Kerosene 2.0%	.0032	92.2
Spitzenberg	oil and natural wax	Unwashed check	.076	—
Spitzenberg	oil and natural wax	Hydrochloric acid 0.60%	.063	17.1
Spitzenberg	oil and natural wax	Hydrochloric acid 0.60%+Kerosene 1.0%	.040	47.3
Spitzenberg	oil and natural wax	Hydrochloric acid 0.60%+Kerosene 2.0%	.034	55.2
Spitzenberg	oil and natural wax	Hydrochloric acid 0.60%+Kerosene 2.0% and fruit put through washing machine two times	.019	75.0
Spitzenberg	oil and natural wax	Hydrochloric acid 0.94%+Kerosene 2.0%	.016	79.0

The straight kerosene-acid mixture proved to be very effective in the flood-type machine. Remarkably consistent results were obtained by washing the laboratory-prepared apples with the various combinations. The hydrochloric acid alone did not clean the fruit below the .01 tolerance, but with 1 per cent kerosene added to the acid the residue was brought well below the required limit. Putting the fruit through the

machine two times, again demonstrated the beneficial action of the kerosene solvent.

None of the treatments, however, cleaned the Spitzenberg apples below the national tolerance. The apples were so heavily sprayed and waxy, that obviously it was questionable whether even warm acid would clean them satisfactorily. Still, much better removal of the residue was obtained with the different kerosene-acid combinations than with acid alone. When 2 per cent kerosene was used even better cleaning was obtained than when only 1 per cent was added. Also, when the fruit was put through the machine two times, the amount of residue was further reduced materially.

DISCUSSION. The studies taken as a whole show that oil-covered or waxy fruit is cleaned more effectively with mixed solvents than with acid alone. Practically, however, their use is limited. Fruit heavily coated with lead arsenate and oil or wax cannot be cleaned below the national tolerance by the organic solvent-acid combinations. Where the fruit analyzes consistently only a little over the tolerance, the addition of the organic solvent to the acid would lower the residue safely below this limit. Where wide variations occur in the residue load on individual fruits and when the residue is badly coated with oil or accumulated wax, heating the acid solution still remains the most efficacious procedure. Sometimes, for very bad cases, a combination of warm acid and the organic solvent may prove necessary and advantageous.

Necessarily no definite recommendations can be made for cleaning fruit by washing with combined solvents. Where conditions are favorable for their use, kerosene is advised. In the flood-type washing machines where sufficient agitation occurs, straight kerosene may be used. In the jet-type machines the emulsion must be prepared. The organic solvents should never be used in the flotation-type machine where little or no agitation occurs.

Kerosene, used as high as 2.0 per cent has not caused injury to fruit even when the acid is warm. This applies, of course, only to waxy or oil-covered fruit.

It is apropos of the subject to emphasize that complications caused by oil or wax may be avoided as suggested in a previous paper. (JOUR. ECON. ENT. V. 22, p. 693.) The proper use of a suitable grade of oil will not interfere with the washing process. Also, if fruit is harvested at the optimum time for each variety and washed immediately, not enough wax will form to prevent the removal of the residue. This is confirmed by the experience of many orchardists who have washing facilities to clean their fruit in seasonable time.

ADJOURNMENT: 5:00 P. M.

Proceedings of the Second Annual Paper-Reading Session of the Eastern Branch of the American Association of Economic Entomologists

This meeting was held at the American Museum of Natural History, New York City, on November 20 and 21, 1930. The session was called to order by acting-chairman P. J. Parrott.

PART I. BUSINESS PROCEEDINGS

FIRST BUSINESS SESSION

Thursday, November 20

The following report of the secretary-treasurer was read and referred to the auditing committee:

REPORT OF THE SECRETARY-TREASURER EASTERN BRANCH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Membership in the Eastern Branch at the close of the November 1929 meeting amounted to 101 paying members, of which number 13 were affiliated members. The potential membership of Eastern Branch territory is over 300.

The membership was distributed as follows:

West Virginia	1	Rhode Island	2
Virginia	5	Massachusetts	6
District of Columbia	6	Vermont	1
Maryland	5	New Hampshire	0
Delaware	2	Maine	0
Pennsylvania	9	Canadian Provinces	1
New Jersey	26		
New York	27	Total	101
Connecticut	10		

Forty-six papers were presented at the November 1929 meeting. These were distributed by topics as follows:

General	2	Oriental Fruit Moth	6
Equipment	2	Japanese Beetle and Related Species	5
Insects Injurious to Animals	1	Mexican Bean Beetle	2
Insects Injurious to Ornamentals	2	European Corn Borer	1
Diseases and Parasites of Insects	3	Insects Injurious to Fruit, Vegetables and Field Crops	14
Insecticides, involving physics and chemistry	6		
Bees	2	Total	46

Thirty-five of these papers were published in the February 1930 issue of the JOURNAL OF ECONOMIC ENTOMOLOGY, occupying 154 pages and 7 plates. Nineteen text figures were included.

The Secretary received from Dr. T. J. Headlee a letter dated January 20, 1930, stating that the Executive Committee at the Des Moines meeting had formally

approved the articles of agreement covering the organization of the Eastern Branch, with the proviso that such approval should not carry with it the expense of publishing the proceedings of the Eastern Branch.

FINANCIAL STATEMENT

Cash Receipts

Amount received from 1929 dues (101 members)	$202.00	
Receipts from sale of advertising in February 1930 issue of Jour. Econ. Ent. from 15 firms (including an overpayment of $50 from Carbide & Carbon Chemical Co.)	689.98	
Amount received from 1930 dues (51 members)	102.00	
Total receipts		$993.98

Cash Payments

Postage—1929	$ 34.10	
Postage—1930	20.60	
Return of over-payment (Carbide & Carbon Chem. Co.)	50.00	
Stationery	19.50	
May 28, 1930, printing Nov. 1929 Proceedings	538.72	
Miscellaneous expenses (telegrams, expressage, etc)	1.99	
Total payments		$664.91
Balance on hand (deposited in Trenton Trust Company)		$329.07

Respectfully submitted,
Harry B. Weiss, *Secretary-Treasurer*

November 17, 1930

The following report of the Publication Financing Committee was presented by Mr. Safro and accepted:

REPORT OF THE PUBLICATION FINANCING COMMITTEE OF THE EASTERN BRANCH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

This Committee was charged with two functions. One was to devise means of raising sufficient funds to publish the Proceedings of the first paper-reading annual meeting held in November, 1929. The second function was to recommend means by which continued financing of the Proceedings may be effected.

Part I

This Committee raised by the sale of advertising $639.98, all of which has been turned over to the Secretary-Treasurer of the Eastern Branch and disbursed by him in the publication, in the February, 1930, issue of the Journal of Economic Entomology, of the Proceedings and attendant expenses. This first function of the Committee has been discharged and the records closed.

Part II

In accordance with the second function, this Committee recommends that a committee of three be appointed by the President, the function of which will be to present to the Executive Committee of the American Association of Economic Entomologists at the Cleveland meeting, the following proposal:

That each officially recognized Branch of the parent Association be allowed the publication of 50 pages, in the Journal of Economic Entomology, of its annual Proceedings without charge to the Branch.

That the next 50 pages, or portion thereof, if any, be published by the JOURNAL provided half of the expense of publication be defrayed by the Branch.

That matter in excess of 100 pages is to be entirely paid for by the Branch concerned.

That for these purposes, it is suggested that the charge per page be not in excess of $3.00.

That if possible, the Branch reports appear in the next succeeding issue of the JOURNAL after the meeting, otherwise in the second issue following, and that the full report of the Branch Meeting be published in one issue.

This Committee of three should be empowered to negotiate with the Executive Committee of the parent Association and to accept in behalf of the Eastern Branch, any plan which in their judgment is acceptable. All charges to the Eastern Branch resulting from this or an equivalent arrangement should be payable from the Branch funds.

Respectfully submitted,
S. W. BROMLEY
WILLIAM MOORE
I. L. RESSLER
J. G. SANDERS
V. I. SAFRO, *Chairman*

November 20, 1930.

Acting-chairman Parrott appointed the following committees:

Auditing—W. J. Schoene, V. I. Safro, C. C. Hamilton.

Nominations—W. E. Britton, C. R. Crosby, L. M. Peairs.

Resolutions—T. J. Headlee, Hugh Glasgow, S. W. Bromley.

The Secretary proposed Mr. L. R. Streeter, Geneva, N. Y., and Mr. F. G. Mundinger, Geneva, N. Y., for affiliated membership, and they were duly elected.

Dr. L. O. Howard spoke of the changes in economic entomology during the past twenty-five years and of his pleasure in attending the sessions and meeting fellow-workers.

FINAL BUSINESS SESSION

Friday, November 21

Acting-chairman Parrott called for the report of the nominating committee, which was adopted.

REPORT OF COMMITTEE ON NOMINATIONS

For Chairman, W. J. SCHOENE
For Vice-Chairman, PHILIP GARMAN
For Secretary-Treasurer, H. B. WEISS

W. E. BRITTON
C. R. CROSBY
L. M. PEAIRS
Committee

Chairman-elect W. J. Schoene then took the chair and called for the reports of the auditing and resolutions committees, both of which were adopted.

REPORT OF AUDITING COMMITTEE

New York, N. Y., Nov. 20, 1930

The undersigned committee has examined the records, receipts and vouchers of the Secretary-Treasurer, and found them correct and in good order. The balance on hand as of November 17, 1930, is confirmed in the amount of $329.07.

W. J. SCHOENE
C. C. HAMILTON
V. I. SAFRO

Following this, it was voted that the report of the Secretary-Treasurer be adopted.

REPORT OF RESOLUTIONS COMMITTEE

New York, N. Y.,
November 21, 1930

To the Eastern Branch of the American Association of Economic Entomologists:
Gentlemen:

Your committee on resolutions desires to present the following report:

(1) RESOLVED, That the sincere thanks of the Eastern Branch of the American Association of Economic Entomologists be tendered the Director of the American Museum of Natural History and his associates for their kindness in furnishing the quarters for these meetings and for the many other courtesies that they have afforded the members of this Association at their second Annual Meeting and further, that the secretary be hereby instructed to send this resolution, together with his note of appreciation, to the governing body of the American Museum of Natural History.

(2) RESOLVED, That the Association express its most sincere appreciation of the vigorous and successful efforts of its committee on publication, which secured the bulk of the monies necessary to finance the proceedings of last year's meeting, and which has worked out what appears to be an eminently practical scheme for financing the publication of this and future years' proceedings.

(3) Inasmuch as one of the primary reasons for the formation of the Eastern Branch was to enable its members to exchange ideas on the status and future requirements of outstanding regional insect problems, be it resolved

a. that it is the sense of this meeting that a program of this nature should occupy one entire half-day's session, or as much thereof as may be considered necessary, and be regularly made a part of the annual program.

b. that the formation of this phase of the program be placed in the hands of the executive committee and the secretary.

Respectfully submitted,
T. J. HEADLEE
R. D. GLASGOW
S. W. BROMLEY

The executive committee was authorized to select the time and place of the 1931 meeting.

The chairman then appointed C. H. Hadley, F. Z. Hartzell and J. L. King as a committee to present to the Executive Committee of the American Association of Economic Entomologists, at the Cleveland meetings, the proposals outlined in the report of the Publication Financing Committee.

The sessions were attended by approximately 105 entomologists. During the noon recesses Mr. A. J. Mutchler and Mr. C. H. Curran, of the Museum staff, conducted groups through the newly opened Asiatic Hall and the Hall of Preparation, adding thereby to the pleasure and success of the meetings. The Museum restaurant very kindly served luncheon in the Flying Bird Hall so that the members could dine together.

HARRY B. WEISS,
Secretary-Treasurer

The following members and visitors were present:

Allen, H. W., Moorestown, N. J.
Arnold, R. B., Richmond, Va.
Badertscher, A. E., New Brunswick, N. J.
Bailey, H. L., Montpelier, Vt.
Beckwith, C. S., Pemberton, N. J.
Borodin, D. N., Yonkers, N. Y.
Botsford, R. C., New Haven, Conn.
Brigham, D. T., New Haven, Conn.
Britton, W. E., New Haven, Conn.
Bromley, S. W., Stamford, Conn.
Brower, A. E., Ithaca, N. Y.
Burdette, R. C., New Brunswick, N. J.
Butcher, F. G., Ithaca, N. Y.
Campbell, F. L., Washington, D. C.
Chapman, P. J., Geneva, N. Y.
Claassen, P. W., Ithaca, N. Y.
Clement, R. L., Hempstead, N. Y.
Cory, E. N., College Park, Md.
Courtney, O. K., Camden, N. J.
Crawford, H. G., Ottawa, Canada.
Crawford, R. W., Geneva, N. Y.
Crosby, C. R., Ithaca, N. Y.
Curran, C. H., New York, N. Y.
Daniel, D. M., Geneva, N. Y.
Davidson, W. R., Silver Spring, Md.
Davis, W. T., Staten Island, N. Y.
Dills, L. E., Ithaca, N. Y.
Dirks, C. O., Orono, Me.
Driggers, B. F., New Brunswick, N. J.
Dye, H. W., Middleport, N. Y.
Felt, E. P., Stamford, Conn.
Filmer, R. S., New Brunswick, N. J.
Fox, Henry, Moorestown, N. J.
French, G. T., Richmond, Va.
Friend, R. B., New Haven, Conn.
Frost, S. W., State College, Pa.
Gambrell, F. L., Geneva, N. Y.
Garman, Philip, New Haven, Conn.
Gilbert, A., Hempstead, N. Y.
Ginsburg, J. M., New Brunswick, N. J.
Glasgow, Hugh, Geneva, N. Y.
Glasgow, R. D., Albany, N. Y.
Grant, D. H., Scotch Plains, N. J.
Gray, John, Moorestown, N. J.
Hallock, H. C., Westbury, N. Y.
Hamilton, C. C., New Brunswick, N. J.
Hammer, O. H., Ithaca, N. Y.
Harman, S. W., Geneva, N. Y.
Hartzell, Albert, Yonkers, N. Y.
Hartzell, F. Z., Geneva, N. Y.
Hartzell, J. W., Moorestown, N. J.
Hawkins, J. H., Orono, Me.
Headlee, T. J., New Brunswick, N. J.
Henninger, A. H., New York, N. Y.
Hill, L. L., Ithaca, N. Y.
Horsfall, J. L., New York, N. Y.
Howard, L. O., Washington, D. C.
Huckett, H. C., Riverhead, N. Y.
Jennings, C. E., New Haven, Conn.
Johnson, J. Peter, Shelton, Conn.
Johnson, V. A., Camden, N. J.
King, J. L., Moorestown, N. J.
Langford, G. S., College Park, Md.
MacAndrews, A. H., Syracuse, N. Y.
MacLeod, G. F., Ithaca, N. Y.
Maugham, F. B., Ithaca, N. Y.
McConnell, H. S., College Park, Md.
McCormack, R. A., Baltimore, Md.
McCreary, D., Newark, Del.
Menuson, Jr., H., Yonkers, N. Y.
Moore, William, New York, N. Y.
Mundinger, F. G., Poughkeepsie, N. Y.
Nelson, F. C., Roselle, N. J.
Newton, R. C., Moorestown, N. J.

Peairs, L. M., Morgantown, W. Va.
Phillips, E. F., Ithaca, N. Y.
Phipps, C. R., Orono, Me.
Rawlins, W. A., Ithaca, N. Y.
Rex, E. G., Trenton, N. J.
Richmond, E. A., Riverton, N. J.
Roark, R. C., Washington, D. C.
Ryberg, M. E., Yonkers, N. Y.
Safro, V. I., New York, N. Y.
Sanders, J. G., Philadelphia, Pa.
Sanders, P. D., College Park, Md.
Schoene, W. J., Blacksburg, Va.
Selley, R. M., New York, N. Y.
Sherman, R. W., Camden, N. J.
Simpson, G. F., Ithaca, N. Y.
Stene, A. E., Kingston, R. I.
Stockwell, C. W., Camden, N. J.
Turner, Neeley, New Haven, Conn.
Van Buren, B. D., Albany, N. Y.
Wade, J. S., Washington, D. C.
Wagoner, C. C., Newburgh, N. Y.
Walton, W. R., Washington, D. C.
Warren, A. J., Moorestown, N. J.
Weiss, H. B., New Brunswick, N. J.
Whitmarsh, R. D., Deland, Fla.
Wilcoxon, Frank, Yonkers, N. Y.
Williams, L. L., Newark, Del.
Wolcott, G. N., Barneveld, N. Y.
Woodruff, L. C., Ithaca, N. Y.
Worthley, H. N., State College, Pa.
Zappe, M. P., New Haven, Conn.

PART II. PAPERS

Thursday morning, November 20, 1930

THE INITIATION OF ENTOMOLOGICAL EXTENSION WORK IN HAITI

By GEORGE N. WOLCOTT, formerly *Entomologist, Service Technique, Port-au-Prince, Haiti*

ABSTRACT

Many unique difficulties attended the initiation of entomological extension work in Haiti, the most obvious being that none of the major crops had important insect pests susceptible to artificial control. Only by working with the insects attacking ornamentals and minor crops grown for local consumption could an entirely inexperienced and constantly changing personnel obtain the desired experience. However, after three years of diversified and more or less preliminary work, a reasonably competent and amply equipped force of men was promptly available to demonstrate methods of control of the numerous pests of tobacco when a change in the tariff suddenly and very greatly stimulated the production of this crop.

Many of the problems connected with entomological extension work in the Republic of Haiti are decidedly unique, or have features differing from anything to be experienced elsewhere. It is hardly to be expected, therefore, that any will have a direct application for members of the present audience, but it is to be hoped that the solutions of some of them may be suggestive, or that this account of their unexpected singularities will at least prove interesting.

The purpose in initiating all agricultural extension work in Haiti was to stimulate increased production of the main export crops of the Republic, for upon all raw materials exported is levied a rather considerable tax. The funds derived from this export tax form one of the main sources of income for the Haitian Government, and an increased pro-

duction of crops for export is directly reflected in the funds available for paying off its indebtedness to foreign creditors. It was felt by all that upon the rapid liquidation of these debts largely depended the early withdrawal of the forces of the American Occupation. Thus, the control of insects attacking crops produced for local consumption, altho desirable, was not of primary importance, and was rather to be depreciated or minimized.

As absolutely no economic entomological work with a scientific basis had previously been done in Haiti, it was necessary to make a general insect pest survey of the island before beginning any extension work. It was expected, of course, that numerous pests would be found causing such serious damage to the principal export crops that they could be used for giving obvious, not to say spectacular, demonstrations of the value of mechanical or chemical control. Such expectations, however, were doomed to disappointment. The first of the unique features of Haitian agriculture to be discovered was that no insect pest seriously limits the productivity of any crop grown on an extensive scale. Logically, considering the primitive methods of agriculture practised in Haiti, nothing else could have been expected. Quite naturally, any major pest, or disease, or other unfavorable condition which could not be counteracted by some simple, traditional means, readily available and within the resources of the peasants, long ago would have entirely eliminated from production any crop thus adversely affected. But such a result, quite as naturally, would be unforeseen by technically trained scientists, previously unacquainted with primitive agriculture.

Coffee is easily first in export value of all the crops of the Republic, being grown in all the mountainous districts, yet it is so free from insect injury as to be most discouraging as a field for the activities of the economic entomologist. In near-by islands, coffee has numerous pests, some of which cause major injuries, but Haiti has been so separated from intercourse with the rest of the world, and so impervious to the introduction of all things foreign, that incidentally it has escaped the introduction of numerous foreign pests.

Cacao is grown to some extent in much the same region as is coffee, but in recent years, the prices paid for this product have been so low that it is rarely worth bringing out of the mountains to the depots of the exporters located along the coast. Mealybugs and aphids, by sucking the juice from the stems of the tender flowers and the young pods so greatly weaken those infested as to cause them to wither, being much aided in their activities by the protecting care of ants. Yet cacao trees produce so bountifully, despite the presence of these pests, that it is

doubtful if their complete elimination would greatly increase profitable yields. A smaller number of large pods per tree is much to be preferred to many smaller ones, and this desirable result is naturally obtained when the aphids and mealybugs are undisturbed.

Logwood is another natural product obtained on a large scale from the interior of Haiti, but from lower elevations and in regions where rainfall is less abundant. Altho not native, these trees grow as abundantly and naturally as grass in regions which are natural pastures, crowding out other trees and forming pure stands in the extensive areas best meeting their growth requirements. Logwood trees may have some insect pests, but none are apparent to casual inspection, and certainly none that would repay the expense of artificial control.

Along the coast and in the lowlands of southern and central Haiti, cotton is extensively grown, for soil and climate are well adapted to its needs. The variety constituting the great bulk of the commercial crop has been grown so long in Haiti as to be considered native, and its periods of growth and maturing of bolls have been adjusted by the processes of natural selection to take advantage of the seasonal distribution of rainfall. Vegetative growth takes place during the late spring, and thruout the summer and fall, while the production of bolls is limited to two, or at most three, winter months.

In many of the other West Indies, the cotton leafworm, *Alabama argillacea* Hübner, inflicts very serious losses in the years when it is present, but altho this plague occurs every year in Haiti in great abundance, growers are convinced that an abundance of caterpillars means a heavy production of bolls, and rarely can be interested in control measures. They claim that, at least under the conditions existing in their fields, cotton grows too high unless the plants are defoliated several times, and experimental evidence tends to corroborate their view. Careful experiments indicate that absolute protection from the caterpillars produces a larger crop only if the plants are widely spaced apart and have ample room for lateral development, and such conditions are not typical of native fields.

The white scale of cotton, *Hemichionaspis minor* Maskell, is omnipresent in Haiti, being especially abundant on tree cotton plants several years old. Altho the scale has numerous parasites and predators, they appear to be powerless to check its spread. Yet it is not a serious pest in commercial fields, rarely infesting more than the base of the plants. To our casual observation, Haitian growers appear to give practically no attention to their perennial cotton plantations except to harvest the crop, yet the customary practise of cutting off the old plants at the sur-

face of the ground, and burning them after picking is finished, most effectually prevents the white scale, or indeed any other of the scale insects, from becoming abundant or causing serious damage.

The pink bollworm, *Pectinophora gossypiella* Saunders, was first noted in Haiti in 1923, presumably having flown across the Dominican border, and by the next year was found in all parts of the Republic. Yet in determining the distribution of this insect, it was observed that the native cotton was so rarely infested that one might consider it practically immune, and all heavy infestations proved to be on some other variety. The result of the advent of this pest, therefore, was to rapidly eliminate all other kinds of cotton, but as the native cotton already constituted the great bulk of the commercial crop, no decrease in production was apparent.

Admirably adapted as the native cotton is to the climate of the regions where it now grows, and to escaping injury by the pink bollworm, it is by no means perfect, and indeed is most susceptible to internal boll rots. These diseases, however, can be largely eliminated by the control of their normal insect vector, the cotton stainer bug, *Dysdercus andreae* L. The "stainers" injure the cotton directly by staining the lint of the mature boll as long as it is not separate from the seed, and also prevent its development while still green in the unopened boll. They are most injurious indirectly however, for the punctures made by their beaks in sucking nourishment from the seeds in the immature bolls furnish a ready means of entrance for fungus spores and bacteria which cause the rots. Native growers have been accustomed to depreciating the losses suffered from such rots, if noticed at all. Nor can they be convinced of the connection between the presence of these brightly-colored bugs on the cotton and rots which develop later. Naturally they see no reason for destroying the stainers, no matter how easily it may be accomplished.

The growing of sugar-cane at present is by no means as extensive in Haiti as at times in the past, and all the larger plantings are for a single mill under foreign control. The manager of this factory, profiting by the results of entomological researches conducted in Porto Rico while he was in charge of a mill there, had adopted all those measures which were applicable to conditions in Haiti, but was eager to co-operate in applying any recently developed measures or insecticides to problems with which he was not already familiar. An outbreak of the West Indian leafhopper, or "fly", *Saccharosydne saccharivora* Westwood, on one of the properties under his control furnished an excellent opportunity for trying out against it the recently developed calcium cyanide dust. The insects began to fall from the infested leaves almost immediately the dark cloud

of poisonous dust was spread among them, and the demonstration of its value seemed to be a great success. But the manager, and several laborers, too much interested in the effect of the fumes to take proper care for their own safety and keep a reasonable distance away, began to cough and sneeze and complain of headache, and its further use was vetoed, at least for application by any employee of the mill.

The one distinctive pest of sugar-cane in Hispaniola is a caterpillar that feeds on the leaves of high cane, the adult being a brown butterfly, *Calisto pulchella* Lathy. In years past, these caterpillars caused great damage to extensive plantings on new cane at the large mills in the Dominican Republic at the other end of the island. They appear to become abundant, however, only on large plantings, and are so scarce on the smaller fields of the Haitian peasants as to cause no appreciable damage, and even on the largest fields in Haiti are not sufficiently numerous to warrant attempts at commercial control.

Coffee and cacao, logwood, cotton and sugar constitute the bulk of the exports from Haiti: the products on which all efforts to stimulate increased production were to be concentrated. Yet none of these crops offered much chance for improving methods of production, at least from the standpoint of insect pest control. To interest the better educated, more influential, and politically and commercially powerful Haitians in the economic aspects of entomology, they had to be approached on the basis of what could be done for some rather minor crops, or for ornamental plants in the grounds around their homes. In some respects, however, the modest way in which the work was started was most fortunate, for it permitted the gradual development of a more competent personnel of spray-pump and dust-gun operators, whose activities could be more carefully supervised at first than would have been possible if a real emergency demanded immediate attention.

To one accustomed to dealing with farm laborers and independent farmers, who, from early youth have been familiar with the adjustment and repair of complicated farm machinery, the abysmal ignorance of all Haitians, whether peasant or city-bred, educated or uneducated, of even the simplest mechanical contrivances is a continued source of difficulty in recruiting the most modest of entomological demonstration forces. Students of the agricultural college invariably preferred employment making less strenuous demands on their muscle, and one who was a failure in his studies but possessed of a magnificent physique, proved quite incapable of carrying a spray-pump in the field, or of directing others, and after repeated trials had to be dropped from consideration. Another boy of slight stature, who had graduated from the first class of

agricultural students, proved both willing and intelligent, so much so indeed as to be quickly promoted to other work. The most competent employee had previously worked in a garage, and altho at first completely ignorant of what he was doing, or why, could follow out instructions to the letter, and could keep spray-pumps functioning and in good repair despite the crude and inept treatment they were constantly receiving from the laborers he directed.

Most of the earlier spraying was conducted on ornamentals about the houses of those willing to let the unwelcome Americans show what they could do, and thence spread to citrus trees in the yards, which were being invaded by the recently introduced black Aleyrodid, *Aleurocanthus woglumi* Ashby. By far the most extensive spraying was carried on against the West Indian peach scale, *Aulacaspis pentagona* Targioni, which infested a peach growing district of considerable size and importance at Kenscoff. While some of these peach trees were under the control of peasant proprietors, most of them were around the homes of wealthy and influential persons from Port-au-Prince, who had their summer homes there, high in the mountains. The difficult conditions under which this work was conducted made its successful outcome all the more creditable, for the pumps and concentrated oil emulsion had to be carried on mule-back up the mountain, and the water for dilution also had to be transported long distances for many of the trees and small groves.

The same scale is also a most destructive enemy of the papaya, on which host it is much more difficult to control because of the susceptibility of the papaya trees to injury by insecticides. A large planting of papayas was kept free from scale by carefully destroying all infested alternate hosts near it, by constant inspection to discover infestations in their incipiency, and by careful spraying, or scrubbing, of the infested parts of the trunks of the plants to eliminate the scale before its more extensive spread made this impossible without killing the trees. It formed a most interesting demonstration of the possibility of commercial papaya production when proper care is taken to prevent this most destructive pest from gaining a foothold in the grove.

Although the majority of Hatian cotton growers were convinced of the benefits resulting from letting the leafworms defoliate their cotton, or at least certain that no permanent injury resulted, a few were willing to be shown how easily the caterpillars could be killed. We of course think it very simple for the operator of a dust-gun to go down one row and up the next, and eventually cover the entire field with poison, but the problem is by no means so simple in Haiti. In only the most exceptional instances were the cotton plants ever planted, they merely happened to grow.

They do not occur in rows, but hap-hazard over the field, almost invariably too close together, and interspersed with plants of other economic crops, not to mention trees and weeds. Nor are the cotton plants of a height where hand-operated dust-guns can be used to advantage, for ordinarily they are as high as one's head by the time the caterpillars first appear in the late spring. Instructing a prospective dust-gun operator in the office how the operations were to be conducted was very simple compared with his problem of even attempting to carry out instructions. As a matter of fact, he never did carry them out in native plantations, but the earlier imperfect demonstrations when he went into the field at one side, circled around once and came out on the other side declaring the work was finished, later gave place to more systematic efforts as some comprehension was obtained of what thoro dusting implied.

Really effective demonstrations could not be made, however, until fields of cotton with the plants planted in rows were available, and these were only made by foreigners primarily interested in sisal growing, who needed some other cash crop to grow between the sisal plants while they were still small. In such plantings, most effective demonstrations could be made, and in such fields the destruction of the caterpillars was of real benefit, for between the rows of young sisal plants the cotton had ample room for lateral expansion, so that, if properly topped, the energy devoted to vegetative growth produced an extended framework on which enormous crops of bolls were matured.

These combined sisal and cotton plantations, being kept clean of weeds in a manner not typical of native agriculture, were often heavily infested with several kinds of cutworms and sphinx caterpillars. These normally fed on the weeds, but when their normal hosts were devoured, or destroyed by cultivation, they at once began to eat not only the cotton leaves, but even to chew holes in the thick tough leaves of the sisal plants. Bran was not available for making up poison baits to kill these caterpillars, and flour was used instead with admirable results. Bran would have been much better, but for a most unexpected reason. The laborers inquired if the white powder in the flour sack was really flour, to which the man in charge incautiously replied in the affirmative, altho quickly assuring them that it was poisonous because it had been mixed with poison. Two days later, the flour had disappeared, and when the laborers were questioned, replied that on the first night some had been given to a dog which did not die, and the next night all the remainder had been used for human consumption. Only the extreme poverty, or rather destitution, of the Haitian peasants, of all that we take for granted

in the way of manufactured articles, makes such incidents possible, but it has numerous other manifestations. The dust-guns and spray-pumps were not molested, for there was nothing about them of value to the peasants, but any casual discarded tin can that had been used for measuring out the concentrate was so valuable to them that a constantly renewed supply of them had to be available to take the place of those which disappeared—cans with a smooth edge around the top used for holding rolled oats being most prized.

The foreign managers of the sisal and cotton plantations could appreciate the connection the cotton stainer bugs and the internal boll rots which wrought such havoc to their yields, and they readily agreed to detail the one or two laborers necessary to make the hand collections of these bugs at the time when such collections were most effective. Between seasons, the vast majority of these bugs perish from lack of food, so that at the beginning of the cotton season only a few are alive to appear on the prematurely opening bolls. It is from these few individuals, however, that the hordes of bugs develop which later swarm in the cotton fields towards the close of the picking season. By collecting and killing these first few individuals, the later infestation can be largely forestalled and eliminated. The equipment required consists only of a small can partly filled with kerosene and water. The laborers are incredulous that one can be satisfied with a 12 oz. can only nearly full of the dead bodies of the stainers as a result of an entire day's work, but more should not be expected. As the season advances, the size of the can may be increased or the collections checked up several times during the day, but at no time should they be large, and they may be safely discontinued at about the time that other growers are beginning to be annoyed by the presence of vast swarms of bugs on their cotton. The success of the demonstration was so obvious that the manager of one plantation started independent collections the next year, only asking to be advised when they should be commenced. His crop had been almost free from loss due to internal boll rots, and the contrast with another plantation, just across the road, where no attempt to check the bugs had been made, was too obvious to be ignored.

Native cotton in Haiti, being practically free from attack by the pink bollworm, and requiring no precautions for guarding against injury by this pest, is for that reason alone ordinarily much more desirable than other varieties, even those which give a larger crop of better quality if planted so as to mature just ahead of the native cotton. Some foreign growers, misled by their success with a small planting of Mead into thinking that this could be repeated again the same year on a much

larger scale by a second planting on irrigated land, were later among the first to admit the value of the unheeded advice that had been proffered them regarding the dangers attendant on neglecting this most insidious pest. Those who profited by the recommendations and based their plantings on seed selected from superior strains of native cotton suffered practically no losses from pink bollworm injury.

The application of chemical insecticides for the control of injurious insects is more readily comprehensible by even the most ignorant of peasants than is any measure of control based on cultural methods. They are accustomed to doing things in a certain traditional way to obtain successful results, but that this success depends upon having prevented insect injury to their crop seems quite preposterous. In some sections of Haiti, an introduced pest of bananas, the root, or corm, borer, *Cosmopolites sordidus* Germar, had recently appeared and was doing great damage. It was with considerable trepidation that the proposition of making a survey of the distribution of this pest, and of instructing the peasants as to the cultural methods by which it could be controlled was entrusted to a temporarily employed agent. He was of the most superior intelligence and ability, and was willing to devote a year of his time to such work only because it enabled him to earn money with which to continue his interrupted medical education. It was thought that possibly because of his previous success in inducing them to carry out public health measures, he might be able to obtain at least partial success in this much more difficult problem. He discovered, however, what the peasants had already learned from experience, that some varieties of plantains and bananas were either much less infested by the weevil than were others, or they were normally of such vigorous growth as to be able to produce fruit despite its presence. Few of the peasants had seen the insect causing the damage, and none of them realized that it was the cause of the death of their banana plants, but they could not fail to see that some kinds of bananas no longer did well, and these they no longer planted. Thus the varieties most susceptible to attack, or most heavily infested, were rapidly disappearing from cultivation. As a result, the agent was then able to advise growers in regions where the pest had not yet appeared of the more desirable varieties with which they might replant their grove to replace the susceptible kinds, when the pest appeared in their locality.

The same agent, while working on another problem involving the use of poison insecticides, reported a common objection by the peasants to having their crops protected by this means. They claimed, with ample justification, that even if they learned to use the small amounts of poison

which could be presented to them by the extension service, no additional supplies could be obtained by them from merchants in town, none of whom could be convinced of the desirability of stocking with such substances, for which previously there had been no demand. To meet these objections, large supplies of the more common insecticides were purchased by the extension service, to be sold at cost to the farmers. Surprisingly enough, some of them actually did make use of this opportunity to obtain insecticides at minimum prices. As an outgrowth of these large purchases, additional amounts were also obtained to be supplied to the rural primary schools and demonstration farms which were being established in all parts of the country. Large boxes with padlocked covers were made, to be filled with a selection of insecticides adapted to their needs, together with a spray-pump and a dust-gun, while instructions for use were pasted on the inside of the top of the box. From personal knowledge, little can be reported as to the use of the contents of these boxes, as their control was transferred to other authorities, but the teachers of the schools and the agents in charge of the demonstration farms had received adequate training in the application of insecticides, and in a few cases reports were received of their making impressive demonstrations of their value.

The real opportunity for showing the value of economic entomology in Haitian agriculture came only after several years. A revision of tariff schedules had suddenly made the local production of tobacco for consumption in Haiti most profitable, and many persons with no previous experience in its growing attempted its cultivation, often on a rather considerable scale. A number of insect pests at once began to dissipate their hopes of easy money and big profits, and in desperation, several of them applied to the extension service for advice. Fortunately, most of the pests of tobacco are susceptible to control by insecticides, an ample supply of which was available, so that the growers could not only be given advice and a demonstration, but also be furnished with liberal supplies to take care of their requirements for the first season. Most of them were unpleasantly surprised to learn how large a part of the budget for tobacco production in other islands in the West Indies is for insecticides, so that even if they were able to save their crop by this means, it was not all clear profit.

Tobacco had been successfully grown on a small scale for many years in Haiti, using traditional methods that in some respects differed considerably from those common in other tobacco regions. The seed-beds, for instance, instead of being on new land from which the vegetation had been burned off, were on elevated platforms. The new, inexperi-

enced growers, however, planted level on land that had previously been used for other crops, and were invariably much disappointed after vainly waiting several weeks, that few or no seedlings appeared. Many theories were advanced for the failure. One grower was sure that it was due to ants carrying away the seed, and made preparations to eliminate them from his property. However, when the primitive practise of using an elevated platform was brought to the attention of the commercial growers, and adopted by them in modified form, such an abundance of seedlings was produced within a few days as to occupy all available land which could be prepared for the young plants.

Tobacco is a most satisfactory crop on which to make demonstrations of insect control, for results are obtained immediately. Either the plants are up and making the seed-bed green with their tiny leaves, or one may be sure that they will never appear. When planted in the field, cutworms destroy them immediately, or poison baits and poison on their leaves preserves them intact. Flea-beetles make lace-work of the leaves, or the poison dusted on them keeps them sound and whole. It is thus at every stage of growth, including harvesting, curing, and even storing, for warehouses must be fumigated if the tobacco is to be kept there safely until needed. Thus when the suddenly expanding tobacco industry in Haiti insistently demanded advice, insecticides and experienced dust-gun operators, every request for aid could be promptly met by the entomological extension service, largely because of the extended training and somewhat discouraging experience which had been obtained while dealing with the insect pests of other crops.

ENTOMOLOGY IN PUERTO RICO DURING THE PAST DECADE[1]

By M. D. LEONARD, *Chief Entomologist, Insular Experiment Station, Río Piedras, Puerto Rico*

ABSTRACT

A brief review of the more important entomological activities, pure as well as applied, during the years 1921–1930, notes on the principal workers, and suggestions as to future lines of investigation.

PREVIOUS ACTIVITIES

In the Journal of the Department of Agriculture of Puerto Rico, 6 (2): 3–11, 1922, Dr. G. N. Wolcott, then Chief Entomologist of the Insular Experiment Station at Río Piedras published a paper entitled "The

[1]Acknowledgment is due Dr. Wolcott and Mr. Sein, both of whom have been kind enough to read MS and make constructive suggestions on this paper.

Status of Entomology in Porto Rico." In this paper he most ably reviews the entomological activities to date of Barrett, Crossman, Van Zwaluwenburg, Cotton, Jones, and others, as well as his own, dating from the establishment of the Federal Experiment Station at Mayagüez in 1903 and of the Insular Experiment Station at Río Piedras. This latter was established in 1910 by the Sugar Producers' Association but due to failure of support was taken over by the Insular Department of Agriculture in 1914 and its scope enlarged to include studies on all crops grown in the Island. Wolcott also touched on the work of still earlier agriculturalists and naturalists who had written upon the insects of Puerto Rico. Most notable of these were Dr. Juan Gundlach, a German-Cuban and Dr. Augustin Stahl of Puerto Rico, who catalogued most of our earliest records of Puerto Rican insects.

As Wolcott points out, most of the entomological work in Puerto Rico had only been in progress for about ten years at the time of his summary in 1921. Considerable had been accomplished however. Best known probably are Van Dine's studies on cane insects, the careful work on life-history and control of white grubs in cane by Smyth and the explorations and introductions of parasites of white grubs by Hood and Wolcott. The publications of Barret and Van Zwaluwenburg on the changa or Puerto Rican mole-cricket were important contributions and the devising of the Paris green-flour mixture by S. S. Crossman in the control of this pest was an outstanding piece of successful work. Tower studied citrus insects and devised methods for their control. He did much to develop both beekeeping and the plant quarantine service on the Island. Important studies on vegetable insects were made by Cotton and by Jones and some attention was paid by Smyth to the insects attacking cotton. Coffee insects had received some attention from Hooker at Mayagüez. Mention should also be made of the extensive studies in insect transmission of sugar cane mosaic caused to be initiated by the late Prof. F. S. Earl, one of the outstanding authorities on this disease, who worked for several years in Puerto Rico, beginning in 1918. E. G. Smyth was the first contributor to this important subject, followed by Tower at Mayagüez and by Wolcott, Seín and others at Rio Piedras.

During the years 1912–1914 entomological activities were at a high peak in Puerto Rico with nine well-trained entomologists working at the two experiment stations during those years on problems in connection with major crops. This was largely due to the pressing need for the immediate solution of major problems, especially in the tobacco and sugar industries. The need was most adequately met by one outstanding personality, Mr. D. L. Van Dine, singularly gifted in selecting suitable

men for particular positions and enlisting their unswerving loyalty under his direction. With the completely, or partially, successful solution of some of these problems shortly after his departure, the entomological personnel has steadily decreased in numbers, and indeed reached a minimum during the decade with which this paper deals. Mr. F. Seín Jr. has been continuously Assistant Entomologist at the Insular Station since the fall of 1920 and also J. D. More until 1923; G. N. Wolcott, Chief Entomologist from 1921 to 1924; H. L. Dozier from 1924–1925 and the writer during the present calendar year. Mr. W. V. Tower continued his excellent work as Entomologist at the Federal Experiment Station at Mayagüez until 1924 when he resigned to enter commercial work with the tobacco growers.

The changing personnel has, as is usually the case, been responsible for some lack of continuity of research but changing conditions on the Island have also tended to produce interest in problems somewhat different from those which engaged the attention of the entomologists working in the previous decade.

Activities of 1921–1930

Sugar Cane. Upon his second appointment to the Insular Experiment Station in 1921, this time as Chief of the Division of Entomology, Wolcott did not resume attempts at parasite introductions for white grubs in which he had formerly been so active. He did however publish in 1922 an excellent paper entitled "Parasite introduction into Porto Rico" (Jour. Dept. Agr. P. R. 6(1): 5–20) in which he summarized all of the work done to date, not only the attempts to introduce the parasites of white grubs and the cane mealy bugs, *Pseudococcus calceolariae* Mask. and *P. sacchari* Ckll. but also of the hornfly of cattle.

Studies in parasite introductions of both white grubs and the moth stalk borer were resumed in 1925 however by the Central Aguirre Sugar Co. which employed for the purpose Mr. H. E. Box, an English entomologist of considerable experience in the tropics. Up until 1927, Mr. Box made several trips to South America, chiefly to Venezeula, for the purpose of obtaining parasites for shipment to Puerto Rico. In 1927 he published an excellent paper in the Jour. Dept. Agr. P. R. 9 (4) : 291–356, entitled "Porto Rican cane grubs and their natural enemies" in which is summarized much of the work he did. Early in 1927 he was accompanied on a trip to Venezuela by Mr. L. I. Catoni, Chief Inspector of the Puerto Rican Plant Quarantine Service. The results of this trip were presented by Mr. Catoni in a paper entitled "Informe del viaje verificado a Venezuela con objeto de introducir parasitos para combatir

el taladrador de la caña de azucar on Puerto Rico," in Rev. Agr. P. R. 18 (5):252–254, 1927. Mr. Box's work for the Central Aguirre Sugar Co. has been continued to-date by Mr. Herbert T. Osborn, Jr.

Sugar cane being the most important crop on the Island it is only natural that continued attention has been paid to insect pests of this crop. Between 1921 and 1924 Wolcott published several important papers on the moth stalk borer and on minor pests of cane and continued to experiment with the control of the moth stalk borer and of white grubs. In 1922 Mr. C. E. Chardón then of the Insular Experiment Station presented good evidence for the first time, that *Aphis maidis* Fitch, which normally feeds on grasses, was undoubtedly an important, if not indeed the most important, natural factor in the spread of sugar cane mosaic on the Island. Mr. Seín, in 1922 became interested in the subject of mosaic transmission and its possible insect vectors and has continued his investigations up until the present time. For the purpose of obtaining data on how the virus of sugar-cane mosaic is introduced by the insect vector into the plant tissues he devised a simple and efficient new method of artificial innoculation (Jour. Dept. Agr. P. R. 14 (2): 49–68, 1930. He has also conducted many careful experiments both upon the possible insect vectors of cane mosaic and the behavior of the active principle in the plant. These are to appear in print during the coming year.

Root-pests of cane undoubtedly take great toll of the crop in Puerto Rico. Some of these have received careful consideration by Mr. Seín and he has recently published a paper on the sugar cane root-caterpillar, *Perforadix sacchari* a new genus and species (Jour. Dept. Agr. P. R. 14 (3): 167–191, 1930). This insect is widely distributed and injurious in the Island. In this paper other new or little known cane root pests are also discussed.

Between 1921 and 1924 when he resigned, Wolcott published several other papers on cane insects including the minor sugar cane insects, factors influencing the abundance and control of the moth borer, and a list of cane insects of Santo Domingo, (Jour. Dept. Agr. P. R. 9 (4): 357–367, 1924). Dozier in 1925 published an important paper on an unusual outbreak of the red striped sugar cane scale, *Pulvinaria iceryi* Guerin (Jour. Dept. Agr. P. R. 9 (4): 357–367).

COFFEE. Insects affecting coffee have possibly not received the attention due them during the past ten years. Wolcott however spent considerable time in making a survey of the pests of this crop, third in importance in the Island, and published circulars on the coffee leaf-miner

and the stem-borer and experimented with the control of the "hormiguilla" —the coffee shade ant—which often causes much damage by hollowing out tunnels in the coffee shade trees, and later attacking the coffee trees themselves, causing weak spots so that the branches break off when the berries are being picked.

More detailed studies on the parasites of the coffee leaf-miner and the factors influencing their abundance have recently been started.

TOBACCO. The control of the more injurious tobacco insects had already been fairly well worked out but in 1921 and 1922 informative literature was published by Wolcott, More, and Seín. Tower, at Mayagüez paid considerable attention to the control of the cigarette beetle by cyanide fumigation and was able to materially reduce the considerable losses occassioned by this insect to both baled tobacco and cigars in the tobacco warehouses.

CITRUS. The life history, habits and control of the more important citrus insects have received considerable attention during the past ten years. Tower conducted many spraying experiments while entomologist at the Mayagüez Station until 1924 when he resigned. For the past several years Mr. Tower has been a consulting expert for some of the leading citrus growers and in that capacity has carried on important entomological control work from the practical standpoint.

During 1924–1925, Dr. H. L. Dozier studied citrus insects and was responsible for the introduction into Puerto Rico of calcium caseinate (Kayso) as an emulsifying agent in preparing home-made oil emulsions. He published in 1925 in collaboration with Dr. Mel. T. Cook, Chief Pathologist of the Insular Experiment Station, a paper entitled "Spraying citrus fruits in Puerto Rico (Cir. 88, Ins. Exp. Sta. P. R.) which is the latest and best work on the diseases and insects of this crop.

COTTON. Since cotton has for some years been a profitable crop in Puerto Rico, the finding of the pink boll-worm in 1921 was a serious matter. A careful survey was conducted by Wolcott, More, and Seín in cooperation with the Insular Agricultural Extension Division. The infestation was found to be light and mostly confined to the Eastern end of the Island. In spite of a vigorous eradication campaign, the pest is now found wherever cotton is grown but due to fumigation of all seed, the maintenance of a closed-season, and systematic clean-up measures, it rarely causes any considerable loss.

The writer has paid some attention to cotton pests during the past season. A mimeographed circular on the control of cotton insects was prepared and widely distributed, and later published in the Rev. Agr.

P. R. 25: 135–136 and 163–164, 1930. A new leaf-miner of cotton was found to be abundant altho not injurious on the South Coast and a complete paper was published on it under the name of *Nepticula gossypii* n. sp. in collaboration with Dr. W. T. M. Forbes of Cornell (Jour. Dept. Agr. P. R. 14 (3): 151–157, 1930).

BANANA. Late in 1921, the banana root-weevil, *Cosmopolites sordidus* Germ., was discovered for the first time in the Island. It has gradually spread from a comparatively small initial center of infestation till it now includes nearly the whole Island. Altho its life-history and habits in Puerto Rico still need additional study, the Insular Station has from the first continued to attempt, in cooperation with the Extension Division, to demonstrate known control methods used with fair success in certain other countries. The problem is a difficult one in Puerto Rico. Altho bananas are an important source of food for the poorer classes, they are grown almost as a "back yard" fruit and control measures necessitating community effort and but little expense, are difficult to put into operation.

VEGETABLES. Some work was done by Wolcott and by More earlier in the decade on vegetable insects. For the most part however these workers have been content, having other more pressing problems, to rest upon the previous thoro publications of Cotton and of Jones. Since the hurricane of 1928, there has been increasing interest in the growing of vegetables as a necessary article of diet. It is also realized that top prices can be had during the winter months in New York for Puerto Rican vegetables. The Division of Entomology at the Insular Experiment Station has been receiving an increasing number of requests for information on the control of vegetable insects and the writer has been paying considerable attention to the insects of these crops. A paper on the Tingid bug, *Corythucha gossypii* Fab., a major pest of lima beans on the Island, has been completed and a study of the lima bean pod-borer, *Maruca testulalis* Geyer, is in progress.

SILK CULTURE. In an attempt to develop a possible industry which would bring in an additional income, especially to the country people in the higher parts of the Island, Mr. Seín has been experimenting since 1922 with the culture of mulberry varieties and of silk worms. Both the mulberries and several varieties of Chinese worms have done well, until the past year when what may prove to be the flacherie disease seems to have been introduced in a fresh shipment of eggs from China. Lack of both time and funds have as yet prevented the initiation of cultural experiments on anything like a commercial scale.

BEEKEEPING. In 1923, Mr. Seín published a circular of the Ins. Exp. Sta. showing that honey bees are neither beneficial nor detrimental in the pollination of coffee flowers. The experiments were conducted in an effort to counteract propaganda carried on by several agriculturists who attributed the lessening of the coffee crops to the then popular beekeeping industry. Due to this propaganda and the falling off of high prices for honey brought about by the World War, beekeeping in Porto Rico has greatly fallen off. There has recently been a slight revival in the industry, however.

EXTENSION ACTIVITIES. The Extension Division of the Insular Department of Agriculture and Labor now under the direction of Mr. I. L. Torres has been active from time to time in conducting insect pest surveys and control or eradication campaigns. Chief of these within the past ten years have been those in connection with the cotton pink boll-worm, the banana root weevil, and the sweet potato weevil. There is now in progress a cleanup campaign against the cocoanut weevil on the whole coastal margin of the Island.

In order to assist in the rehabilitation of the coffee industry, badly crippled by the hurricane of 1928, the American Red Cross appropriated a large sum of money for the establishment of coffee seed-beds. This work was placed under the direction of the Extension Division. Over a million seedlings have been raised in these seed-beds, distributed thruout the coffee districts, and furnished to the growers free of charge. One of the chief problems in the production of seedlings was the coffee leaf-miner. Excellent control, however, has been obtained by the local Agricultural Agents in charge, by careful and systematic spraying with nicotine sulfate and soap.

QUARANTINE SERVICE. A discussion of Entomological activities in Puerto Rico would not be complete without reference to both the Insular and the Federal Plant Quarantine Service. Organized in 1911 and for several years efficiently headed by Tower and later by Smyth, the Insular Service has been under the immediate direction since 1920 of Mr. L. A. Catoni, a graduate of the College of Agriculture at Mayagüez and for a time an assistant entomologist at the Insular Experiment Station. The Insular Plant Quarantine Board, consisting of the Commissioner of Agriculture, Extension Director, Chief of the Division of Plant Pathology and Entomology of the Insular Station, and the Chief Inspector of the Service, acts in an advisory capacity. Several meetings of this Board are held each year to pass upon the more important Plant Quarantine matters.

As a result of a hearing held in Washington in 1924 to consider chiefly restricting or prohibiting entry of citrus fruits from Puerto Rico on account of the West Indian Fruit Fly, *Anastrepha fraterculus* Weid,[2] the U. S. Plant Quarantine and Control Administration agreed to establish a permanent office in Puerto Rico. This was done the following year. It now maintains, besides Mr. Richard Faxon, the officer in charge, two additional inspectors. One of these, Mr. A. S. Mills is a trained entomologist, and the inspector at the Port of Mayagüez, Mr. A. G. Harley is also primarily an entomologist. Close and efficient cooperation is effected between this office and the Insular Service as well as the two Experiment Stations.

THE FEDERAL STATION AT MAYAGÜEZ. Entomological investigations at the Federal Station at Mayagüez have been almost at a standstill since the resignation of Mr. Tower in 1924. His work has already been referred to. It is expected, however, that Dr. H. L. Dozier, now entomologist for the Department of Agriculture in Haiti, will be appointed as Entomologist at Mayagüez to take up his duties early during the coming year.

Dr. S. T. Danforth, head of the Department of Zoology at the College of Agriculture at Mayagüez gives instruction in entomology. This is worthy of note since it is thru his department that most of the official agricultural agents and other similar workers have gained their knowledge and appreciation of the importance of local entomological problems.

MEDICAL ENTOMOLOGY. For many years malaria has been widespread and often serious in Puerto Rico. In 1921, Tower made a mosquito survey of Mayagüez and published the results with recommendations for control as Circular 20 of the Mayagüez Station. H. W. Greene, working on the South Coast for the Rockefeller Foundation between 1921 and 1923 studied the disease and made observations on the habits of the local species of Anopheles. Since 1924 extensive studies on malaria control have been in progress under the direction of Dr. Walter C. Earle of the International Health Division of the Rockefeller Foundation. Large scale experiments have been carried on in cooperation with several of the leading sugar companies, giving due consideration to the importance of the suppression of Anopheles mosquitoes, thru extensive ditching and drainage operations and the use of larvicides. Encouraging results have been obtained but the problem is complicated and much work is yet to be done. (See Earle, Am. Jour. Trop. Med. 10(3): 207–230.

[2]The specific identity of the Porto Rican material is as yet somewhat in doubt.

Within the last few years Dr. F. M. Root has made important studies on Porto Rican mosquitoes (Am. Jour. Hyg. 2:394–405, 1922). Dr. W. A. Hoffman of the School of Tropical Medicine at San Juan has been working with Dr. Root and also studying the classification and life-histories of the "jejen"—Culicoides—locally called "mages" or "plagas," a most annoying pest in many localities on the Island.

THE SCIENTIFIC SURVEY OF PUERTO RICO. Basic to the study of applied entomology is a thoro knowledge of the species of a region and their distribution within it. One of the outstanding contributions to our knowledge of the insects of Puerto Rico was Wolcott's well-known "Insectea Portoricensis" (Jour. Dept. Agr. P. R. 7 (1) : 1–313) published in 1924. In it are listed about 2250 species with, as far as was known, the distribution, food-plants or hosts of each.

In 1914 the New York Academy of Science in cooperation with the Government of Puerto Rico started a Scientific Survey of Puerto Rico and the Virgin Islands. From that time to the present a number of specialists have visited the Island, and collected many specimens, among them during the past ten years being Leng, Lutz, Needham, Rehn, Herbert Osborn, and W. T. M. Forbes. Up to the present time however only the Diptera by Curran in 1928, and the Lepidoptera (in part) by Forbes in 1930 have appeared in print. It is hoped that the Coleoptera, Hemiptera, Odonata and the remainder of the Lepidoptera will appear during the coming year or two. Outside of the regular "Survey" papers by Rehn and Hebbard have published on the cockroaches (Bull. Am. Mus. Nat. Hist. 54, Art. 1: 1–32, 1927), Prof. Osborn on the Homoptera (Jour. Dept. Agr. P. R. 13 (3): 81–112, 1929) and supplementary papers are now in preparation on the crane flies, by Alexander, the midges, by Johannsen and the Lepidoptera in part (by Forbes) for publication, in the Journal of the Department of Agriculture of Puerto Rico; also on Diptera (miscl.) by Curran in Am. Mus. Nat. Hist. Novitates.

INSECT PEST SURVEY. The writer has been acting as collaborator of the Insect Pest Survey of the U. S. Bureau of Entomology and a complete report on the status of the more important crop pests will be sent in at the end of the year.

CONCLUSION

In conclusion, reference should again be made to the excellent work of Dr. Wolcott in Puerto Rico. During the three and one-half years of his second connection with the Insular Experiment Station, from Jan. 1921 to June 1924, he published 33 titles on entomological subjects cover-

ing most of the major pests of the Island. Probably the two most important of these are his "Insectae Portoricensis", already mentioned and his "Entomología Económica Puertorriqueña" (Ins. Exp. Sta. Bul. 32, 176 pp., 1924), a real hand-book of applied entomology for the Island. Both of these papers are indispensable to Puerto Rican workers and have commanded favorable attention elsewhere.

About 120 titles on entomological subjects have appeared from 1921–1930 in the official publications of the Island. Altho some of these represent largely informative literature or compilation, many present the results of careful, and in some cases outstanding, research.

One of the greatest needs of entomology on the Island is several more entomologists. The physical equipment is now fairly satisfactory, the Division having recently moved into roomy new quarters in a modern concrete building. A new insectary has also just been completed. During the first three to four years of this past decade there were four official full-time entomologists on investigational work; from 1924–1925 only two; and then for four and one-half years until the appointment of the writer in Jan. 1930, Mr. Seín was carrying on alone. Of course Mr. Tower and Herbert T. Osborn Jr., have been doing important work for private interests. The value of the sugar, tobacco, coffee, and citrus crops alone, amounting to millions of dollars, in addition to that of cotton, bananas, cocoanuts and vegetables, should amply warrant the employment of additional investigators. Mr. Francisco Seín Jr., trained at Cornell, is practically the only native-born economic entomologist which Puerto Rico has as yet produced. Mr. Julio García Diaz, head of the division of biology at the University of Puerto Rico, obtained his Master's degree in Entomology at Cornell and has been carrying on studies on dragon flies and may flies. There should be others for research, and especially needed is a well-trained man to work in connection with the increasing activities of the Agricultural Extension Division. The present salary scale should undoubtedly be raised, however, in order to attract young Porto Ricans to enter such work.

Parasites of the sugar cane moth stalk-borer, white grubs, and of the coffee leaf-miner should be further studied; the life-history and control of the banana root-weevil should be thoroly investigated; and the citrus industry should receive much more attention from entomologists than it has. Specialists in various groups of insects should be encouraged to visit the Island and while enjoying respite from northern winters in its delightful climate, be given assistance in pursuing their own special collecting methods in order to increase our knowledge of the insular insect fauna.

In conclusion, it may be pointed out that the more important insect pests of Puerto Rico are among the root and tuber feeding forms, stemborers, and leaf-miners. A special opportunity here presents itself for investigation of the insects of these distinct ecological environments. It is to be hoped that the final establishment of the proposed graduate School of Tropical Agriculture in Puerto Rico under the auspices of Cornell University, will open up the opportunity for fundamental studies of these as well as of the many other problems of which insects are a part.

ECOTOPOGRAPHIC MAPS: THEIR USE IN ENTOMOLOGY AND NOTES ON MAKING

By F. Z. Hartzell, *New York State Agricultural Experiment Station, Geneva, N. Y.*

Abstract

Ecotopographic maps, together with special contours, are defined. Their use for assisting in the investigation of the relation of insects to environment and for illustrative purposes are set forth. The features to be shown on such maps and notes on the methods of making are given.

Definitions. Strictly speaking, the term *map* would include all kinds of cartography, but it is customary to add a definitive adjective to classify the various types. So far as the writer knows there is no adjective or definition which exactly delimits the kind of maps described herewith, hence the following coinage and definition: An ecotopographic (from οἶκος, a house or a place in which to live + τόπος, place or position + γράφω, to sketch or write) map may be defined as a delineation of land and water, showing in orthogonal projection, the relative position of geographical features, works of man, vegetation and animal life, together with representation of the elevation of land, depth of water, height of vegetation and cultural features, relative abundance of animal life, and other factors which can be measured. Briefly, such a map may be described as an ecological map to which the topographic concept is applied to land, water, vegetation, abundance of animal life, and other quantitative data. By the topographic concept is meant the representation of elevation or other quantity by means of contour lines, using color, form, or symbol to distinguish the contours depicting the numerical data of the various features.

To distinguish contours showing equal values of the several characteristics of the map the following terms already in the literature are used: elevation of land, *isohyps;* population density (animals or men), *isodems;* injury by insects or animals, *isofags;* numbers, *isopleths;* and hydrogen-

ions, *isohydrics*. There appears to be no term to describe contours showing equal height of the tops of vegetation above ground; so the writer coined the term *isophyte*, plural *isophytes* (from ἴσος, equal + φυτὸν, a plant). There is, also, no word to describe the idea of equal depths of snow, therefore there has been coined the words *isonif*, plural *isonifs* (from ἴσος, equal + νίφω, covered with snow) for contours showing equal depths of snow cover. The symbols representing the different kinds of contour lines are shown in Fig. 4. The other symbols shown are those commonly used in topographic and military maps.

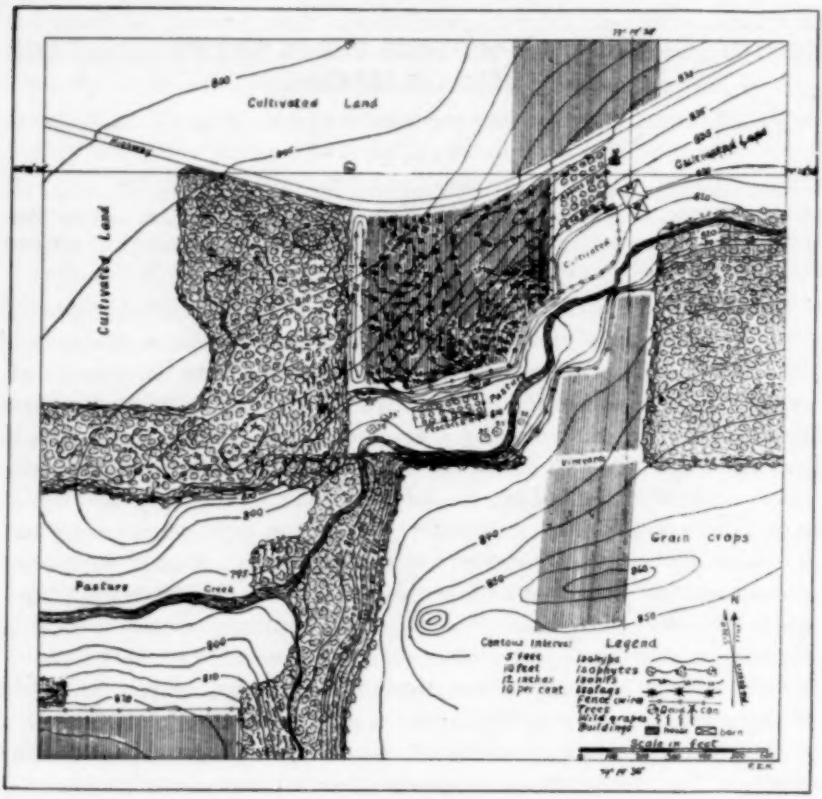


FIG. 4.—Ecotographic map showing relation of environmental complex to injury by grapevine flea beetle and grape berry moth. The isofags show percentage of injury by the flea beetle. The injury by the grape berry moth occurred because the snow drifts were formed outside the vineyard.

USE OF ECOTOPOGRAPHIC MAPS IN ENTOMOLOGY. There are two chief uses to which such maps may be applied by entomologists; *viz.*, research and illustration. Every worker who has studied insect popula-

tion or its effect (injury) has noted that the density or injury varies thruout an environmental complex, sometimes desultory, but often quite regularly. In some instances it may be obvious that the density is related to the environment in a definite manner even tho the specific cause may not be known. Generally the problem is not so simple, expecially when the area is large or the variation in population density small. Whether one desires merely to study the relation of certain features of the surroundings to the insect or whether he attempts to find the specific causes that lead to these correlations, a good ecotopographic map offers the first and best approach to the problem.

There are three good reasons for investigating relations of insects to their environments, *viz*, (1) to check the data secured by insectary studies in order that correct conclusions may be drawn, especially as regards seasonal history; (2) to determine what factors favor or retard increase in insect populations; and (3) to learn how man can economically change an environment and thereby lessen the possibility or severity of insect attack. The latter reason seems to be very important in this era of entomology when spray practices involve a heavy expense for the fruitgrower, and especially since the spray residue problem has loomed so large. As an example of what can be done, it might be mentioned that the writer has been able to control the grapevine flea-beetle and the grapeberry moth by changes in vineyard surroundings. Studies of pear psylla indicate that the severity of attack can be reduced by similar changes.

Ecotopographic maps are especially useful for illustration. In fact, no other can take its place if it is desired to show the relative injury or population of an insect in correct relation to all the factors of its environment. The addition of controlled photographs will assist the reader in visualizing the physiognomy of the terrain, but cannot replace a good map. Just as a good drawing reveals the structure of an insect better than a photograph, so generally, a good ecotopographic map shows the structure of an environmental complex better than aerial and ground photographs, and certainly reveals the relative positions of objects better than any ground view. Of course, many factors, such as snow cover, wind velocity, hydrogen-ion determinations, counts of insects, etc., cannot be photographed, but can easily be represented on a map.

In a *controlled* photograph sufficient measurements have been taken to plot the camera stations, and radial lines which show the limits of each view. Also, the position of the level line should show on both lateral margins of the illustration. It is not extravagant to say that all views attempting to show environment should be *controlled photographs* ac-

companied by a small-scale sketch-map—it need not be elaborate—on which are delineated the principal features, structure, and location of the views.

WHAT SHOULD APPEAR ON THE MAP. A complete ecotopographic map should show the following: (1) latitude, longitude, and an arrow showing true north; (2) configuration and elevation above sea level of land and water; (3) extent, type and conformation of vegetation with elevation of top above ground; (4) fences (kind), buildings, and other works of man, giving height; (5) insect population or injury; (6) other features of which it is desired to show quantitative differences, such as snow cover, temperature, etc.; (7) careful lettering and clear symbols which are defined, also the values of a sufficient number of contours should be given thruout the map to permit easy determination of the value of any particular contour; and (8) scale of distances and a statement giving the contour interval for each type of contour shown.

If controlled views are to accompany such a map, the following should be included: (1) location of camera stations with radial lines delimiting each view; and (2) position of conspicuous objects appearing in the view, such as certain trees in a woodland or orchard which otherwise might not be emphasized in the drawing.

A word needs be said about map scales. There are three methods of expressing the relation of the size of the map to the terrain it represents, *viz.*, (1) a carefully drawn scale of distances for comparison; (2) the statement that one inch on the map is equal to a certain number of feet, yards or miles, as 1 inch = 400 feet; and (3) by a representative fraction whose numerator gives the number of inches on the map for the number of inches on the ground, shown in the denominator, e. g., 1/4800 is the representative fraction for a map drawn to the scale 1 inch = 400 feet (4800 inches).

NOTES ON MAPPING. It is not possible in the space allotted to give detailed information regarding principles and methods of mapping. Perhaps the best that can be done is to direct attention to books containing the information and to methods and instruments that can be used successfully. At the end of this article is given a list of a few of the books which the writer has found very helpful. Space requirements forbid a longer list, and for the same reason each will be referred to in the text by number.

There are two distinct mapping methods in general use which might be called *office* and *field*. In office mapping measurements and notes are made in the field, but the map is constructed in the office. Distances are

determined by pacing, stadia or tape, while horizontal and vertical angular measurements are made with the compass and clinometer or with a transit. In field mapping, on the other hand, the map is made in the field by means of a plane-table outfit. No horizontal angles are measured, but directions are indicated by lines whose position on the map is determined by some form of alidade. Vertical angles are measured by means of a clinometer or vertical arc if the alidade is provided with one. Distances are determined by pacing, stadia or tape. In all these lists of instruments and methods, the least accurate is placed first as they are the most easy to procure.

Each method of mapping (office and field) possesses special advantages for certain map scales: the office method for large scale maps (1/120 to 1/1200) where practically all points are located by measurement and little sketching of contours is required; the field method for small scale maps (1/12000 to 1/48000 or smaller) where speed is important and where less control and much sketching is demanded. Ecotopographical maps from which distances are to be scaled will perhaps most frequently fall between the lower limit given for office mapping (1/1200) and the higher limit given for field mapping (1/12000) and here either method may be used, the advantage sometimes being with one and sometimes with the other method. The choice of methods will also depend on the preferences of the surveyor. In learning the art, master principles first from books, paying little or no attention to instruments.

It is believed that a study of mapping can best be approached by means of plane-table methods using scales varying from 1/4800 to 1/12000. To prepare for this books Nos. 1, 2, 3, and 4, or their equivalent, should be studied in the order given. Having learned the principles and methods, the beginner should equip himself with a traverse board, tripod, scales, alidade, compass, notebook, and the necessary drawing equipment. The traverse board consists of a drawing board either 15 x 15 inches or 18 x 21 inches into the center of the underside of which is sunken a camera-bed nut for attaching to an ordinary camera tripod. A triangular rule having the usual engineer's scales will serve as an alidade. The traverse board can be fitted as a slope board. A simple pocket compass completes the outfit which, in the writer's case, cost less than five dollars, excluding the tripod which belonged to the regular photographic outfit. An ecotopographic map should be made of an area with this equipment. Later a combined compass and clinometer that can be used in the hand or fitted to a tripod should be procured. Using this preferably with a tripod and pacing distances, measurements should be made of the same area and a map drawn in the

office. In this manner the user will be surprised and no doubt fascinated to learn that good maps for illustrative purposes can be constructed with simple instruments and to find how easily the principles of mapping can be put into practice. The experiences will illustrate the advantages and disadvantages of the two methods.

In order to make maps sufficiently accurate for scaling distances (working maps), higher grade instruments will be necessary, also a good tape. The choice will be either a plane-table with telescopic alidade and stadia or a transit with vertical circle and stadia. Before making a selection the remaining books given below should be studied and advice secured from men competent to judge between the two methods. The writer has found that a combination of the two methods serves his purposes best. The measurements are made with transit and stadia and the map plotted and partially sketched in the office, after which it is placed on a traverse board and the sketching corrected and completed in the field. When time in the field is limited and controlled photography possible, the most important measurements are taken with transit and stadia, extensive sketches made in the note-book, and the details and physiognomy of the terrain is recorded by controlled views with numerous carefully selected camera stations.

In making controlled photographs an ordinary 5 x 7 plate camera is used. However, the *principal line* and *horizontal line* are drawn on the ground glass from determinations made by the method described in Book No. 7, and pins are set so as to record the location of these lines on the edges of the photograph. In taking the picture the tripod is carefully leveled and the transit or clinometer set at the same height. Two points near the edge of the view are found that are on the level of the camera and the *level line* is made to coincide with these. The azimuth of the center of the view and the location of the camera station are determined by distances or by distances and angles for plotting. The views are used in the office to locate details according to the method described in Book No. 7. The accuracy of a map is limited to the accuracy of the plotting which for good draughtsmen is set at 1/100 inch for distance and five minutes for angles. Thus in a map drawn to a scale of 1/4800, the minimum appreciable error is 4 feet for distance and 27 minutes for a sight 500 feet in length. Determine the minimum appreciable error for the map scale to be used and use corresponding accuracy in the survey. This will avoid needless, time-consuming refinements. The above refers to side shots, but traverse lines should be surveyed with more accuracy to avoid cumulative errors becoming too large. The precision of the different kinds of measurements should be consistent; that is, there is no sense

in measuring angles excessively accurately unless the distances are taken with the same precision, and vice versa.

The following publications have proved very useful in mastering the principles and methods of ecotopographical surveying:

1. Military Sketching and Map Reading, L. C. Grieves. (U. S. Infantry Association, Washington)
2. Engineer Field Manual (Part I Reconnaissance), S. S. Leach. (Government Printing Office, Washington)
3. Topographic Mapping, L. B. Roberts (Soc. Am. Military Engineers, Washington)
4. Topographic Surveying, H. M. Wilson (John Wiley & Sons, New York)
5. Plane Surveying, J. C. Tracy (John Wiley & Sons, New York)
6. Vol. I. Principles and Practice of Surveying: Elementary Surveying, C. B. Breed and G. L. Hosmer (John Wiley & Sons)
7. Vol. II. Principles and Practice of Surveying: Higher Surveying, C. B. Breed and G. L. Hosmer (John Wiley & Sons)
8. Bulletin 788, Topographic Instructions of the U. S. Geological Survey, especially Part E. Topographic Mapping. W. M. Beaman (U. S. G. S. Washington)

OBSERVATIONS ON SHADE TREE INSECTS

By E. P. FELT and S. W. BROMLEY, *Bartlett Tree Research Laboratories, Stamford, Conn.*

ABSTRACT

The dry weather of the past two seasons has been unusually favorable to injury by the elm leaf beetle, *Galleruella xanthomelaena*, and the probabilities favor more damage another year. Early and abundant Tachinid oviposition upon recently molted black walnut caterpillars, *Datana integerrima*, is recorded. There is a summary account of the life history and habits of the maple Nepticula, *Nepticula sericopeza*, together with recommendations for control. Data are given showing that adults of the two-lined chestnut borer, *Agrilus bilineatus*, feed somewhat freely upon foliage and may be killed by spraying with poison. Injury to rhododendrons by a species of Prionus, probably *P. laticollis*, is described. The hibernation of the hickory leaf stem gall, *Phylloxera caryaecaulis*, in the egg stage is detailed and early spraying for the destruction of the young is advised. The results with the spruce gall aphid, *Adelges abietis*, and also the long spruce gall aphid, *Gillettea cooleyi*, show that both are easily controlled by early spraying with several contact insecticides. Unusual injury by the pine spittle insect, *Aphrophora parallela*, is recorded and data given on the life history and control of the Euonymus scale, *Chionaspis euonymi*.

The protracted dry spells of the last two seasons appear to have been unusually favorable to the development of the elm leaf beetle, *Galleruella xanthomelaena* Schrank, and as a consequence, injury in the northeastern United States was exceptionally severe. This was particularly marked in southwestern New England, the Hudson Valley area of New York and portions of New Jersey, the foliage being badly skeletonized and browned in August. The development of this insect was decidedly

later than usual. A serious phase of the situation is that conditions are apparently favorable for increased rather than lessened injury another season.

An interesting observation was made in relation to the black walnut caterpillar, *Datana integerrima* Grote and Robinson. Early in September, a group of these caterpillars came under observation just after they had molted and even before the process was fully completed, Tachinid flies were hovering about the caterpillars. One, two and three eggs were rather commonly seen upon the black heads of the larvae and in several cases, eight or nine were observed. These were all deposited after molting had occurred and most of them within 15 or 20 minutes after the shedding of the skin.

The maple Nepticula, *Nepticula sericopeza* Zeller, kindly determined by Dr. August Busck of the U. S. National Museum, has been under observation for the past three seasons. It was first brought to attention in June, 1928 on account of the heavy leaf fall, accompanied by a somewhat characteristic, variable, sooty black discoloration at the extreme lower part of the leaf stem, and at a point almost exactly half an inch from the base of the leaf, there was a minute, white, elevated, oval object, suggestive of a fungus fruiting body and presumably consisting of dried sap which had exuded from the point of oviposition. The interior of the basal portion of the leaf stem was traversed by very minute channels or mines about three-eighths of an inch long and some at that time, contained a nearly transparent, very slender larva about a sixteenth of an inch long and with a diameter of approximately one-fiftieth of an inch. The dropping of the leaves was so general that season that an examination of selected branches from a tree some 60 feet high, showed a somewhat general infestation, approximately 10% of the leaves being infested. The earlier dropping was considerably in excess of 10%, and it is believed that 25% represents the minimum defoliation in this particular case. Subsequent observations indicate that the miner is probably unable to complete its transformation in the leaf stems and that these are attacked only when there are no seeds available for oviposition.

There was a heavy crop of Norway maple seeds in 1930 and in mid-June, large numbers dropped from the trees. They showed the same type of injury as had been observed in 1928 and 1929 on the leaf stems. It was noteworthy that a very large proportion of the earlier dropping larger seeds, namely 99%, were infested, while of the smaller seeds falling at the same time, less than 14% had been attacked. The infested seeds when green, are easily recognized by the sooty discoloration,

indicating galleries which usually start at one point and upon breaking the seeds apart, there are usually burrows along the suture, partly filled with somewhat characteristic reddish borings. Recently infested seeds generally have the minute white spot, presumably dried sap, as in the case of leaf stalks. There are certainly two and possibly three generations, since moths were observed in greater or less numbers from June throughout July and into August.

The small, dusky, white-marked moths are a trifle over an eighth of an inch long and have two somewhat indistinct silvery or whitish transverse bands when in the characteristic resting position. They usually remain quiet upon the trunks of the tree during most of the day and when disturbed, readily jump into the open mouth of a vial placed over them or flit to a nearby resting place. The moths occur commonly on the rougher portions of the bark and also throughout the tree to some extent, both on the leaves and the fruit.

The full grown larva occurring in the seeds is about three-sixteenths of an inch long and mostly a pale yellowish green. The freshly made, pale orange yellow, oval cocoons have a major diameter of about three-sixteenths of an inch. The cocoon is flattened, the edges merging smoothly with the surface upon which it rests. The older cocoons change in color gradually from a pale orange to a variable yellowish or whitish orange. The insect undoubtedly winters in these cocoons, which weather to such an extent as to harmonize closely with the normal, somewhat variegated bark surface of the tree.

The occurrence of this insect is most easily determined by examining the fallen seeds. There is usually the minute white spot as on the leaf stems and the galleries contain somewhat characteristic reddish orange borings or castings. The insect is known to occur in southern New Hampshire, in eastern and western Massachusetts, in Rhode Island, in many localities in Connecticut, particularly the southwestern portion and in New York, especially along the Hudson Valley northward to Lake George and westward to Syracuse. Infested seeds have also been taken in northern New Jersey and in a locality near Philadelphia.

The wintering of this insect in cocoons upon the trees makes it very probable that a dormant oil application would practically eliminate the infestation. Spraying in late May with a solution consisting of a half pint of nicotine, three pounds of soap and 2 quarts of molasses to 40 gallons of water, gave a very promising degree of control. It killed adults and very probably prevented the issuance of moths from the cocoons. A dormant spray is probably more satisfactory.

The two-lined chestnut borer, *Agrilus bilineatus* Web., is a rather common woodland insect and under favorable conditions may kill individual trees or groups of trees. This is particularly likely to occur in connection with real estate developments. A large series of beetles was reared this season, and it was demonstrated that the adults feed readily on the leaves of red oak and black oak. Seven adults, for example, ate about one-fifth of a leaf in two days. One beetle consumed about one-tenth of a leaf in six days and another one-seventh of a leaf in five days. We were able to demonstrate that beetles restricted to feeding upon poisoned foliage died within 48 hours, while only one out of seven originally placed in a jar with unsprayed foliage was dead at the end of this time. This test was repeated with additional specimens and similar results obtained, and in this latter case, all but one of the beetles succumbed before the expiration of 24 hours. Beetles in cages on sprayed trees gave the same results. One large tree known to be infested by this insect was sprayed with poison and came through the season in good condition, while another nearby tree, untreated, died during the summer from attacks by this borer. The sprayed tree had, however, been sprayed with arsenate of lead early in the season to protect it from defoliation by leaf rollers, and the other tree had not been given this protection, though it sent out a partial second crop of leaves before succumbing to Agrilus attack.

An unusual injury to rhododendrons by a species of Prionus, probably *P. laticollis* Drury, came to our attention the past season. It was limited to maximum rhododendrons. The foliage of infested plants was yellow, scanty, and the stems were weak and easily bent or torn out. Three larvae were found at the base of one stem, one in a root three-fourths of an inch in diameter, and it was evident that the trouble in this planting was of some years standing. There was no question but what these grubs were working in the living tissues, although the galleries were blackened internally and more or less filled with partly decayed organic matter. Tests with Pyrethrol and Red Arrow and Paradichlorobenzene did not give a satisfactory kill of the grubs. Carbon disulfide, however, destroyed them, though we have no information as to its probable effect upon the plants.

The hickory leaf stem gall, *Phylloxera caryaecaulis* Fitch, has been known for years and is occasionally abundant and very injurious. Observations early last spring showed that the dark greenish or blackish eggs only about one-thirty-third of an inch in length may be found in great numbers in the old galls and also to some extent in the bark

crevices. The eggs hatch at the time the buds have swelled considerably and reached a length of approximately half an inch or more. The tiny Phylloxera crawl between the loosening bud scales, establish themselves upon the developing tissues and by the time the young foliage is protruding from the buds, they are already protected by gall tissues. An application of a spray consisting of a half pint of nicotine, three pounds of soap and 9 pounds of molasses to 40 gallons of water or thorough dormant oil applications before the swelling buds are half an inch long will almost certainly control this insect very satisfactorily.

The spruce gall aphid, *Adelges abietis* Kalt., is remarkably local in its habit and in some cases at least, appears to be restricted very closely to individual trees or groups of trees. A series of tests were conducted the past season with the following sprays. Light Volck, 2 quarts, nicotine, one-fourth pint and water 25 gallons. This was applied April 3rd to a number of badly infested Norway spruces and with entirely satisfactory results. Another combination consisting of nicotine, one-sixteenth of a pint and Penetrol, 1 pint to 25 gallons of water, was sprayed on the same date and the control was unsatisfactory, probably due to the very small amount of nicotine used, since the same combination, except that one-fourth of a pint of nicotine was used, gave very satisfactory control on badly infested spruce trees and also on a Colorado blue spruce bearing a number of galls of *Gillettea cooleyi* Gill. A spray consisting of Sun Oil, 3 pints, Penetrol, 1 pint and water 25 gallons, applied the same date, as in the case of the other trees, gave a very satisfactory control on both the Norway spruce and the Colorado blue spruce. It is evident that thorough spraying with several contact insecticides will control the gall aphids of both the Norway and Colorado blue spruces.

The pine spittle insect, *Aphrophora parallela* Say, was unusually abundant in the early summer. An infestation observed June 13th showed from one to as many as 35 spittle masses per branch. The adults began to appear the last of June. This insect was decidedly more abundant on Scotch pines than on white pine and very few were observed upon red pine. We are attempting to obtain some information as to the actual effect of such an infestation upon pine trees.

The Euonymus scale, *Chionaspis euonymi* Comst., winters as a full grown or nearly full grown female. There are probably three generations, since small scales were observed in 1928, June 8, July 19 and October 1. Breeding continues until the very end of the season and was evidenced in 1930 by the occurrence of young scales on bittersweet October 30th. Thorough spraying with Sun Oil 1–15 just before the new

growth starts will control the pest, though it may not be possible to eradicate it with one application. The principal difficulty is to cover the plants so thoroughly that no areas will be missed. This oil treatment causes no material injury, since the old euonymus leaves drop shortly after the new foliage appears.

TESTS ON THE CONTROL OF SEVERAL INSECTS ATTACKING ORNAMENTAL PLANTS[1]

By CLYDE C. HAMILTON, Ph.D., *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

The European pine shoot moth (*Rhyacionia buoliana*) was controlled by spraying infested trees during June with "Penetrol" diluted 1 to 200 plus "Black Leaf 40" 1 to 500. Three sprays were applied at intervals of a week or ten days. These sprays killed the adults hiding in the trees and the eggs laid upon the terminal twigs. The juniper web worm (*Dichomeris marginellus*) and the pine needle miner (*Epizeuris aemula*) were also effectively controlled by means of several summer contact sprays applied in May or early June against the larval stages before the adults had an opportunity to emerge and lay eggs on other plants. The black vine weevil (*Brachyhincus sulcatus*), the grubs of which were feeding on the roots of taxus plants, were successfully controlled in the adult stage by means of a poison apple bait. Tests against a thrips infesting privet showed that dust insecticides were more effective than liquid sprays and that the best materials were dusts containing nicotine tannate or ground pyrethrum flowers. Tests against the elm mite (*Eriophyes ulmi*) showed that sprays or dusts containing sulfur were much more effective than sprays containing pyrethrum extract as the active principle.

The need for work upon the control of insects infesting shade trees, evergreens, ornamental shrubs and flowering plants is becoming increasingly evident each year. Opportunity was presented this spring for testing summer contact sprays as a control for several different species of insects infesting evergreens. It would seem very desirable, if possible, to develop some means of controlling a large number of insects by the use of summer contact sprays which are ordinarily controlled by recommendations of arsenate of lead. Many insects are protected in a webby covering and do not feed extensively beyond this particular area. This is particularly true in infestations where the insects are very nearly grown or have caused considerable damage. Spraying with stomach poisons at this stage of the infestation is often very unsatisfactory and, in addition, it is usually at this stage of the infestation when the damage is first noticed by the persons concerned, therefore any method of control

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

which can be applied safely and effectively at the time when the injury is first noted is very desirable.

EUROPEAN PINE-SHOOT MOTH (*Rhyacionia buoliana* Schiff.) Reports of damage by larvae of the European pine-shoot moth were first received during the spring and summer of 1929. The damage caused by this insect was much more apparent during the spring of 1930.

Craighead and Middleton[2] state that the European pine-shoot moth was first found in the United States in 1914. The species is reported as attacking all species of pine and had become established in Illinois, Ohio, West Virginia, Pennsylvania, New Jersey, New York, Massachusetts, Connecticut, Rhode Island and Florida. They state that it seems to be largely a nursery pest. The experience of the writer, however, has been that it is causing damage in New Jersey, at least to a considerable extent, in ornamental plantings of the various species of pines.

The adult moth has a wing expanse of approximately ¾ of an inch and the wings are marked by irregular bands of bronze or golden bronze scales upon a grayish background. The first moths were noticed in Bergen County on June 8th. They were very abundant from June 16th to the 20th and had apparently all disappeared by about July 5th. The eggs were apparently laid on the stems of the new shoots or on injured twigs on the stems of the old shoots somewhere close to the terminal buds. These eggs are laid singly, are decidedly flattened, yellowish-white in color and have a thin, easily ruptured membranous covering. The eggs are about 1/32 of an inch in diameter. The young larvae, upon hatching from the eggs, crawl to the terminal buds where they bore in the new growth or in the resinous material around old injured buds. The larvae are a rather dull chestnut brown and are about ¾ of an inch in length when full grown. They are smooth and the body contains only very short setae or hairs. Injury in the fall of the year is caused by the larvae boring into the terminal buds. The larvae are only about ¼ of an inch long at the time when they pass the winter, and usually not more than one bud is injured during the fall. Feeding is resumed in the spring and the larvae may injure several buds of the terminal cluster. After the new growth starts the almost full grown larvae often bore in the base of the new shoots. This weakens them so that the shoots bend over or break off close to their base. In late May or early June the injury of this insect is very easily noticed by the lopping over of the infested shoots.

[2]Craighead, F. C. and Middleton, W. "An Annotated List of the Important North American Forest Insects." United States Department of Agriculture Miscellaneous Publication No. 74, May, 1930.

A heavy infestation of this insect in about 2500 pines was called to the writer's attention early in April. This infestation was located in a planting of ornamental trees at the Bergen County State Hospital near Oradell. The infestation had been present for 5 or 6 years and many of the trees had made practically no growth during this time. Two species of pine were infested. In the one species, Red Pine (*Pinus resinosa* Ait.) more than 75% of the tips showed injury, while in the other species Scotch Pine (*Pinus silvestris* Linn.) probably better than 50% of the tips were injured.

On April 23rd several infested trees were sprayed with each of the following materials: "Pineol Soluble" diluted 1 to 10 and 1 to 20; "Penetrol" diluted 1 to 25 and 1 to 50; and a miscible pine oil diluted so that it contained 2% and 4% actual pine oil. "Black Leaf 50" was added to each of the diluted spray materials at the rate of 1 part to 500. The trees had not started active terminal growth at the time the spray was applied and it was thought that possibly the strong concentrations of the spray might penetrate the terminal buds sufficiently to kill some of the larvae. An examination May 2nd of the terminal twigs on the sprayed trees showed no kill in any of the sprayed lots. Rather severe burning occurred on the needles in the stronger solutions, especially where "Penetrol" and the pine oil were used. This burning, however, did not increase and at a later date was barely noticeable.

On June 16th a block of approximately 100 trees were sprayed with "Penetrol" diluted 1 to 200 plus "Black Leaf 40" at the rate of 1 to 500. This spray was repeated on June 23rd and the 30th. Examinations made at several intervals during the height of emergence showed the moths to be much less abundant in the sprayed block than in unsprayed blocks and at the time of the last spray application very few moths were found in the treated block. The moths hide in the trees during the day time and start flight about dusk. Spraying during the day time resulted in killing most of the moths and in addition apparently killed most of the eggs which were laid by escaped moths. Examinations showed an average of 10 to 15 moths per tree in the unsprayed blocks, while only an occasional moth could be found in the sprayed block. An examination made July 28th of the terminal twigs on ten sprayed trees and ten unsprayed trees showed that of 1623 terminals on the sprayed trees 15.5% were infested with larvae while from 1208 terminals on the unsprayed trees 67.5% were infested.

Since the moths are dusk and night fliers it was thought that possibly they might be attracted to trap lights. A 200 watt blue Mazda electric bulb was suspended about 4 feet from the ground and a wash-tub almost

full with water, and the water covered with a light oil, placed about 4 inches beneath the bottom of the electric light bulb. An acetylene torch lamp was arranged similarly in another location. These lights were lit about dusk and were supposed to remain burning all night. In some instances, however, the lights were turned off after having burned a few hours. It was interesting to note, however, that during the height of the emergence of the moths from 400 to 500 adults of the European pine-shoot moth were trapped during some nights with the daylight electric bulb and about 2/3 this many moths with the acetylene light. On other nights very few moths were attracted to the trap lights. Almost no moths were attracted previous to 10 or 11 o'clock at night. The trap lights were continued in operation for a period of approximately 2 weeks and during this time several thousands of moths must have been caught.

One dozen 200 watt bulbs, but not of the daylight variety, were placed at intervals throughout other sections of the infested pines. Most of these bulbs were placed close to the ground with the containers holding the water and oil resting directly upon the ground. These bulbs were set out by the help at the Bergen County Hospital and were not well located. Apparently due to the kind of the light and their location close to the ground they did not catch nearly as many moths on the same nights as did the blue electric light bulb.

TABLE 1. THE RESULTS OF SPRAYING JUNIPER TREES INFESTED WITH JUNIPER WEB WORM WITH VARIOUS CONTACT INSECTICIDES

Spray Material	Live Worms	Disabled Worms	Dead Worms	Total Worms	% Dead	Remarks
1. Lime S. 1–25+B-L-50 1–500	118	19	108	245	44	15 trees sprayed, wet poorest of all the lots
2. Pyrethrol 1–50	20	—	59	79	74	Wet very good but poorer than Penetrol or Pineol Soluble
3. Pineol Soluble 1–10+ B-L-50 1–500	19	—	44	63	70	Wet very good in both tests
Pineol Soluble 1–20+ B-L-50 1–500	8	2	9	19	46	
4. Penetrol 1%+B-L-50 1–500	45	7	23	75	31	Wet very good next to Pineol Soluble
5. Volck 2%+B-L-50 1–500	28	6	19	53	35	Wet fair. Better than Lime S. but poorer than others
Check	41	—	3	44	7	

The results of the tests on this insect indicate that dormant sprays are of no value. Three or four summer applications of a good contact insecticide, however, if applied at intervals of not more than 6 or 7 days beginning with the start of the emergence period, should kill the moths

and in addition probably kill most of the eggs before the larvae hatch and burrow into the twigs. "Penetrol," which is an oxidized sulfonated gas tar oil, proved safe on the foliage with repeated sprayings and was very effective in killing the adults and the eggs.

JUNIPER WEB WORM (*Dichomeris marginellus* Fab.) The juniper web worm has been fairly abundant in nurseries and ornamental plantings and has caused considerable damage to the plants. On April 22nd an infestation in one of the nurseries was treated with a number of spray materials as indicated in the accompanying table. From 10 to 15 trees were sprayed with each material. New growth at the time of spraying had just started. The results of the spraying are shown in Table 1.

The results show a good kill of the worms with the "Pyrethrol" and with "Pineol Soluble" when used at a dilution of 1 to 10 plus "Black Leaf 50." The kill obtained appeared to be very closely associated with the thoroughness of wetting of the webby materials. The infestation was fairly heavy and, as a result, the plants were very hard to wet.

On May 15th and 16th a number of infested trees in this nursery were sprayed with "Penetrol" diluted 1 to 200 plus "Black Leaf 40" 1 to 500 and another block sprayed with a cocoanut fatty acid soap diluted so that it contained 0.75% actual soap plus "Black Leaf 40" 1 to 500. Both sprayed blocks gave a satisfactory field control of the juniper web worm. An examination on May 25th showed some burning of plants sprayed with the cocoanut fatty acid soap plus "Black Leaf 40". This was not serious, however, but by June 3rd it had developed so that the sides of the plants which showed the heaviest infestation of juniper web worm were fairly severely burned by the spray material. This spray burn did not seriously injure the plants, however, and after several months they outgrew most of the injury.

Another nurseryman sprayed a number of fairly large trees infested with juniper web worm with a commercial spray material containing "Black Leaf 50" and soap diluted so that it contained 0.6% of a corn oil soap plus "Black Leaf 50" at approximately the rate of 1 part to 400 parts of diluted spray. This spray was applied on May 27th and examined on the afternoon of May 28th. A kill of 60% of the live worms was obtained. No spray burn or other injury resulted to the sprayed trees.

The results of these spray tests would indicate that a fairly satisfactory control of larvae of the juniper web worm might be obtained early in the spring before the moths emerge by using a good summer contact spray If soap is used, however, as the wetting agent care must

be exercised that too strong a concentration of the soap is not used, otherwise burning may result. A summer control of the juniper web worm, before adults have emerged and spread to other plants, would be very desirable.

SPRUCE LEAF MINER (*Taniva albolineana* Kearf.) An infestation of the pine needle miner on Colorado blue spruce near Phillipsburg, N. J., was sprayed on May 6th with "Penetrol" plus a kerosene extract of pyrethrum so that when diluted the spray material contained 0.75% "Penetrol" and an extract of pyrethrum flowers equivalent to a dilution of 1 pound of flowers to 32 gallons of diluted "Penetrol." A second lot of trees were sprayed with "Pyrethrol" diluted 1 to 100. The trees were very thoroughly sprayed, using a power sprayer and wetting all the infested needles and slightly webbed masses. Material from the sprayed trees was collected on May 9th and examined May 10th. The "Penetrol" sprayed block contained 78 dead larvae, 3 live larvae and 157 pupae. The "Pyrethrol" sprayed block contained 53 dead larvae, 9 live larvae and 98 pupae. A number of these pupae in both lots were dead but it was not possible to obtain an accurate record of the dead and live pupae.

An examination on May 29th showed a few live pupae on the sprayed trees and some moths flying about. The "Penetrol" sprayed block showed slight burning of the tips of some needles. This was not serious. As a whole the results were very satisfactory and have improved the condition of the trees considerably.

BLACK VINE WEEVIL (*Brachyrhincus sulcatus* Fabr.) The black vine weevil was found the past summer injurying several species of taxus plants at several places in the state. The damage was caused by the grubs feeding on the roots, and where abundant the small feeding roots and the bark on the larger roots were entirely destroyed. Damage by these grubs was first called to our attention about the middle of May. Several tests were conducted in treating soil around the infested plants with an alcoholic extract of pyrethrum emulsified with soap and several other emulsifiers and with carbon bisulfide at several strengths. The trees were small and the application was made to an area with a diameter of approximately 2 to 2½ feet. The pyrethrum extracts tested were entirely ineffective. Carbon bisulfide when applied at the rate of 66 cc. per tree and 112 cc. per tree, as well as carbon bisulfide emulsion containing 70% carbon bisulfide applied at the rate of 35 cc., 75 cc., and 150 cc. per tree was entirely ineffective. Carbon bisulfide emulsion was also applied, at a dilution of carbon bisulfide of 1 to 200, at the rates of 1 quart, 2 quarts, 3 quarts, and 4 quarts per tree. This material was also ineffective. The

above materials were applied on May 27th and examinations made 4 days later.

Adults began to appear about the first of June. On the 16th of June a bait called "Go West" and which consisted of scraps of apple impregnated with 3½% sodium fluosilicate was scattered around the base of the trees. Approximately 1 ounce of this bait was applied to each tree. Examinations made on June 19th showed that about 75% of the beetles had been killed. Further applications of this material to the remaining trees in the nursery apparently cleaned up the majority of the beetles. Several nurserymen have informed me that they have been using this material for several years with excellent results against this weevil. It is also claimed by the manufacturers to be of value against the strawberry weevil (*Brachyrhincus ovatus* Linn.).

PRIVET THRIPS. An unidentified species of thrips has been severely injuring privet for the past several years in New Jersey. This thrips was very abundant this year and offered excellent opportunities of testing several materials for its control. Blocks of hedge 12 to 15 feet long were treated with the various materials. The number of thrips were counted on the leaves of a certain number of twigs from each block before treating and counts made of the same number of twigs two days after treatment.

TABLE 1. TESTS OF VARIOUS INSECTICIDES UPON THE PRIVET THRIPS

Dust or Spray Number	Spray or Dust	August 6 15 sprigs pre-spray Count	August 8 post spray Count	Remarks
1	Nicotine tannate 1 pound to 50 gallons plus powdered skim milk 1½ pounds to 50 gallons	193	3	—
2	Nujol emulsion diluted 1–100, 0.7% Nujol	138	31	mostly adults
3	Talc 75% plus nicotine tannate 25%, dust	169	0	—
4	Talc 75% plus ground pyrethrum flowers 25%, dust	146	1	—
5	Talc plus 20–1 extract of pyrethrum dust	176	0	—
6	Wilson's Fung-O plus 10% 20–1 extract of pyrethrum diluted 1–100	88	15	—
7	Red Arrow 1–500	129	9	—
8	Pyrethrol 1–100	123	49	—
9	Pysol 1–200	155	64	—
10	Check	149	146	—

Most of the materials gave a good control of the thrips. Those materials which were applied in a dust form, however, gave practically 100 per cent control. This was evidently due to a better distribution of the insecticide material and possibly to its more lasting effects. It is interesting to notice that nicotine tannate, used in the form of a spray

and of a dust both gave a good control. This control was evidently effective as a stomach poison since observations on other insects have shown that nicotine tannate has little if any insecticidal value as a contact insecticide.

ELM MITE (*Eriophyes ulmi* Garman). The foliage on a number of young elms on the campus of Rutgers College and on nursery trees in several nurseries was observed turning brown in August. Examinations showed the leaves to be heavily infested with a small whitish mite (*Eriophyes ulmi* Garman). Tests of several materials were made against these mites as shown in the following table.

TABLE 2. TABLE SHOWING THE CONTROL OF THE ELM MITE (*Eriophyes ulmi* GARMAN) WITH SEVERAL INSECTICIDES

Kind of Spray Material	Total Number of Mites on 15 Leaves Before Spraying	Total Number of Mites on 15 Leaves After Spraying
1. Lime sulfur diluted 1–50 plus 1 ounce powdered skim milk to 2 gallons	2536	0
2. Pysol 1–200	2906	772
3. Pyrethrol 1–100	5404	1662
4. Niagara Kolodust	4233	0
5. Check	2419	2485

The lime sulfur liquid and the Niagara Kolodust sulfur both gave complete control. It was apparently not a question of distribution of the insecticide so much as the toxicity of the sulfur and its fumes to the mites. The two sprays containing pyrethrum extract were about equally effective.

ADDITIONAL DATA ON THE HOT WATER TREATMENT OF BUXUS[1]

By ERNEST N. CORY, C. GRAHAM, and GEORGE S. LANGFORD

ABSTRACT

Hot water treatment of box plants to control the boxwood leaf miner (*Monarthropalpus buxi*) in the fall and spring show spring treatment to be effective and safe but fall treatment to be inadvisable, though effective.

Last year two of the present authors presented data to show the practicability of hot water for the control of the boxwood miner (*Monarthropalpus buxi*).[2]

It seems worthwhile to publish details of additional hot water treatments of boxwood plants infested with the Boxwood Leaf Miner, particularly so since we now have the results from treatment of a large series of plants in the fall as well as additional data on spring treatments.

[1]Contribution of the State Horticultural Department, University of Maryland.
[2]Journal of Economic Entomology, Vol. 23, No. 3, p. 563–565.

FALL TREATMENTS. In the fall of 1929, 1,019 bushes varying in size from 1 foot to 6 feet in height were treated on November 25, 26, and 28. The equipment for treatment at this nursery consisted of a steel cylindrical tank about 4 feet tall and 4 feet in diameter and an old bath tub, each connected by hose to a steam line. The vats were located in the head house adjacent to the greenhouses. The tallest bushes were treated, one side at a time, in the bath tub. A temperature of 120° F., was maintained within one degree and the immersion period was 5 minutes.

Treatments at this nursery should be divided into two series as follows:

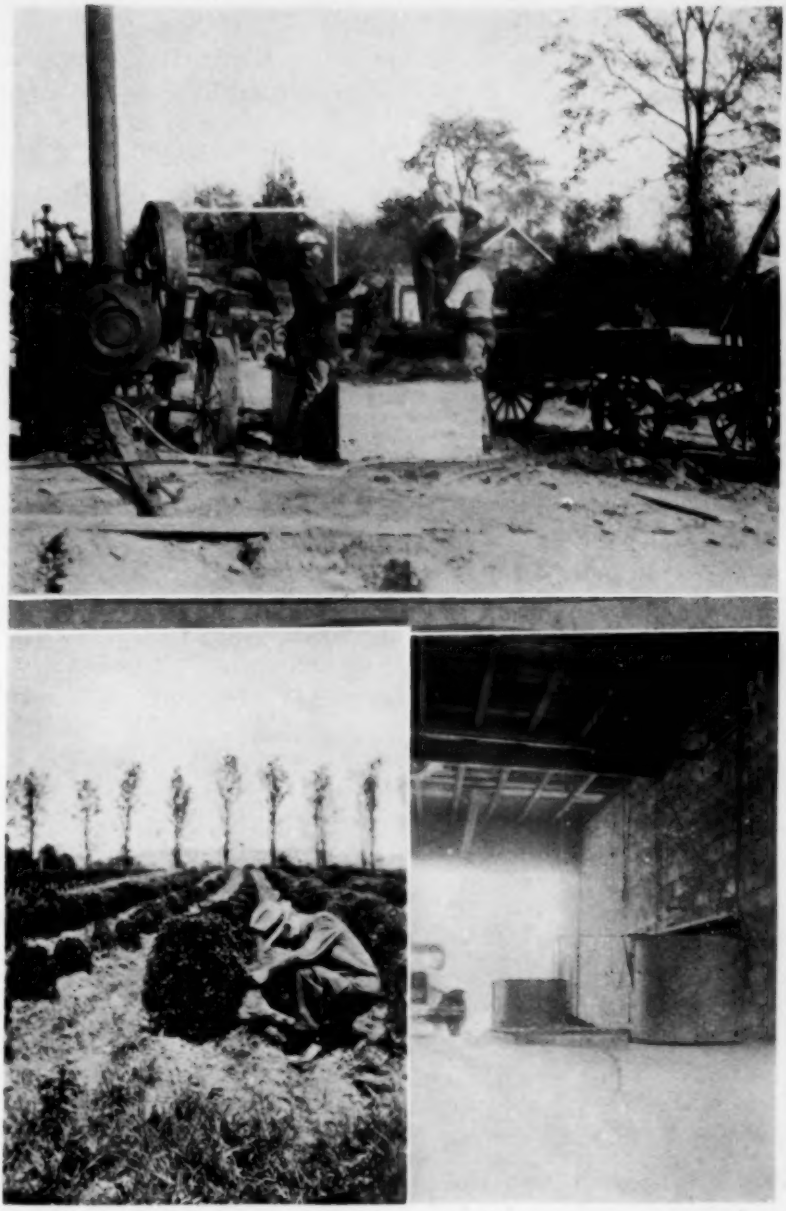
1. Five hundred and sixty-nine plants of *B. sempervirens, arborescens,* and *suffruticosa,* from two to six feet high, were treated during the same period, but were hauled to the field and planted regardless of the low temperatures prevailing. Sixty-seven, or 11.7%, were killed outright and 258, or 45.3%, more were killed back to such an extent as to destroy their commercial value for the present.

All of the above plants were hauled about five miles, planted and then mulched with leaves and manure.

2. Four hundred and fifty plants of *B. sempervirens* from 8–10 inches high were immersed during the period November 25, 26, and 27. These were stored after treatment for several days until the weather moderated and were then planted. Forty-two of these plants died, representing 9.3%, and thirteen more were injured sufficiently to destroy their sale value.

A small lot of thirty *B. sempervirens,* from 18 inches to 2 feet, were treated at College on November 5 by the same method and all suffered severe damage. Twenty-two, or 73%, were killed outright and six of the balance lived until the summer drought killed them. The two that still survive are worthless from the commercial standpoint.

SPRING TREATMENT. Another nursery equipped a steel cylindrical tank, 4 feet high and 4 feet in diameter, with permanent water and steam connections and iron slats to support the plants. The apparatus was located in a garage so that trucks could be loaded and unloaded at the apparatus. Most of the labor employed on this operation was skilled and paid accordingly. The plants were burlapped in the field and retied at the garage by a careful man to insure that no branches were caught in the burlap. From April 16 to 22nd, 4,931 plants, mostly *B. sempervirens,* but with a scattering of *B. suffruticosa,* from one to four feet high, were immersed for 5 minutes in water at 120° F. Some plants were held



Upper.—Portable steam engine and wooden vat used in the treatment of box bushes in the field (Larimer)
Lower left.—Spring dipped plants photographed in midsummer (Sanders)
Lower right.—Two dipping vats with permanent steam and water connections (Langford)

over occasionally for 24 to 36 hours before being hauled the 5 miles to where they were all planted.

One hundred and forty-three, or 2.9%, showed commercial damage and 397, or 8%, were killed or died.

COST OF TREATMENT

	Nursery No. 1	Nursery No. 2
Man labor	$168.00	$378.00†
Truck (oil, gas and operation)	30.00	50.00
Planting	*	85.00
Total	198.00	513.00
Number of plants	1019	4931
Cost per plant	$ .209	$ .104

*Planting cost included in man labor.
†Includes carpenter and plumbing labor.

SUMMARY

In every case the miner was killed and no evidence of reinfestation has appeared.

The costs varied on account of the kind of equipment and the pay of the labor and was moreover higher than last year on account of the long haul, but owing to the value of the plants is economically practicable.

Fall treatment seems definitely to be inadvisable owing to the probability of unfavorable weather conditions and is not recommended in Maryland.

Spring treatment after mild weather sets in and before any emergence has occurred has given control under varied conditions with only temporary injury in most cases. The trees killed in spring treatments may be attributed to causes other than the hot water treatment.

THE LIFE HISTORY AND CONTROL OF THE BIRCH LEAF-MINING SAWFLY, *FENUSA PUMILA* KLUG.

By ROGER B. FRIEND, *New Haven, Conn.*

ABSTRACT

Fenusa pumila Klug., an insect native to Europe, was first reported in the United States in 1924. It is now present in the northeastern part of the country and in southeastern Canada. In Connecticut, there are three generations a season. The eggs are laid in the newly-developing leaves of birch. In Connecticut this insect has been found attacking gray, white, and European white birches. Nicotine sulfate appears to be a promising ovicide.

This sawfly, a native of Europe, was first reported from the United States in 1924 when adults sent from Connecticut to the United States National Museum were determined by Mr. S. A. Rohwer as *Fenusa pumila*

Klug. In Europe this insect has been reported from Sweden, Russia, Great Britain, Germany, France, and Italy, but in these countries it is not considered a serious pest. In the United States it has been found in northern New Jersey, southern and central New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine, and in Canada it has been reported from New Brunswick.

The adult sawfly is a small black insect about three millimeters long and with a wing spread of about seven mm. The males appear to be slightly smaller than the females as a rule, but there is considerable variation in size in both sexes. They may be seen during much of the season from the middle of May to the middle of September hovering above the young birch trees and crawling over the upper surfaces of the leaves. The females oviposit in the leaf, and the presence of the egg may be detected by the minute raised areas in the upper and lower leaf surface. The egg can be seen inside the leaf when the latter is held to the light. The female oviposits in the young leaves only, so that eggs are not found in the fully grown and hardened foliage. When first laid the egg is ovoid in shape and about 0.38 mm. in length, but after a few days it swells to a length of about 0.47 mm.

The adults reared during the investigation of the life cycle show a preponderance of females. Of 1078 individuals reared and of which the sex was determined 432 were males and 646 females. This gives a sex ratio of .60 if one considers that 1.00 represents complete femaleness and .50 represents an equal number of each sex. Whether or not there is a difference in the sex ratio of different generations has not been definitely determined. In 1928, 110 adults emerged from the hibernation cages, 39 being males and 71 females, a sex ratio of .65. In 1930, 70 adults emerged from the hibernation cages, 34 being males and 36 females, a sex ratio of .51. Of 54 adults obtained in field collections made by the writer's assistant in July, 1930, eight were males and 46 were females.

The larva mines in the leaf and has the somewhat flattened appearance characteristic of many leaf miners. After the first molt there are four characteristic black marks on the ventral side of the body. The first of these, on the prothorax, is twice as long as broad and somewhat constricted in the middle, tending toward an hour-glass shape. The second, on the mesothorax, is slightly broader than long and trapezoidal in shape. The third, on the metathorax, is approximately square; and the fourth, on the first abdominal segment, is rectangular but broader than long. There are, of course, slight variations in the shape of these markings. When fully grown and ready to form a cocoon the larva loses these markings and undergoes a quiescent prepupal stage in the soil.

When first hatched from the egg the larva is about 0.9 mm. long, and when fully grown it reaches a length of about 6.0 mm. The cocoon is made up of a thin translucent brownish material to the outside of which adhere small particles of earth and other debris. It is oval in shape, about 4.0 mm. long by 2.5 mm. in breadth. The pupa is white in color until just before the adult emerges, then becoming dark.

The life cycle of this insect is of considerable interest. Healy (1869), who published a brief account of its life history in England under the name of *Fenusa fuliginosa*, states that there are two generations a year in that region, the larvae of the first generation appearing about the middle of June and those of the second brood the last of August and the first part of September. In Connecticut there are certainly three generations a season and perhaps a partial fourth, about six weeks being necessary for the completion of one generation in the summer.

The first adults of the year appear around New Haven about May 12th and lay their eggs in the young developing leaves of the birch. Eggs are frequently laid in the leaf when it is only one-half to three-fourths of one inch long and before it is completely unfolded, but after the leaf tissue begins to harden, the females will no longer oviposit therein. The size of the leaf in which oviposition occurs varies of course with the type of growth, that is, whether the plant is a young vigorous sprout which will bear large leaves or a tree of slow growth bearing small leaves. The result of this selection of a particular stage in the development of the leaf is that only the tips of the branches are infested, with the exception of a few lateral leaves which the first females of the season sometimes utilize. Adults of this generation continue to oviposit until about the tenth of June. In captivity the adults live only a day or two without food. Under natural conditions the length of adult life is doubtless longer. Females will begin to oviposit within 24 hours of the time of emergence from the soil. The largest number of eggs secured from one female in captivity was 23, but dissected females contained from 44 to 96 fully formed eggs in the ovaries and about as many partially developed in the ovarian filaments. The egg hatches in from six to nine days as a rule, but in a few cases this stage has been 13 days in length. A few cases of parthenogenetic reproduction have been noticed, but the larvae were not reared to the adult stage, so the sex of the progeny was not determined. No information is available on the prevalence of parthenogenesis under natural conditions.

When the larva first hatches from the egg it maintains a curved position in the leaf for a day or two before straightening out. The black ventral markings characteristic of the later stages are not present in the

first instar. The mine is of the blotch type and roughly circular in shape. The eggs are laid separately throughout the central area of the leaf, so the mines are distinct when small, but as development proceeds and the mines increase in size they coalesce and form a large dead area in the leaf. The largest number of larvae found in one leaf was 63, in gray birch, but the average is much less. The larvae feed in all directions and assume a position with the ventral side toward the upper surface of the leaf. The larval period in the leaf is from eleven to fifteen days in length, although most of the larvae become fully grown in from ten to twelve days. They then emerge from the leaf and drop to the ground, burrowing in an inch or two before forming the cocoon. In the soil most of the period is spent by the insect in a prepupal quiescent stage. During the summer this stage lasts usually from about nine to fifteen days, and the pupal stage which immediately follows lasts from five to eight days. The total period in the soil during the summer is from about twelve to about 51 days, but the great majority of individuals emerge from the soil in fifteen to 24 days. The total length of time necessary for the completion of the life cycle in the summer is between five and six weeks, probably nearer the latter.

During August and the succeeding days of the summer and early fall an increasing proportion of larvae remain in the soil to hibernate. Although we have secured adults as late as the first part of October, they were very few in number. In 1930 the last larvae of the season observed in Connecticut were on gray birch sprouts at Rainbow, and these had all disappeared by September 26. On birch sprouts, which grow rapidly and produce new leaves in abundance throughout the growing season, a heavy larval infestation occurs from the latter part of May to the last of September, but on well grown trees the foliage of which hardens in midsummer the larval infestation drops off sharply after the second generation has matured.

In New Haven the generations of this insect are rather distinct the first half of the summer, but after this there is so much over-lapping of broods that the insect is found in all stages much of the time. The first generation is completed about the third week in June, and the second generation is over the last of July. There is a third generation which is completed the first part of September, and larvae are found until the last of this month, some of them belonging to a fourth generation.

The effect of this insect on birch trees is distinctive. The oviposition in the leaf causes a grayish discoloration of the leaf tissue around the eggs, and if eggs are at all abundant, this discoloration may extend over much of the leaf area. Larval feeding causes an arrestation of leaf

growth locally, resulting in wrinkling and asymmetrical leaf shape. The leaves do not die if mined to a slight degree, but usually the insect is so abundant that the leaves are killed and drop off, leaving the terminal twigs of the tree bare in midseason. Due to the fact that only the tip leaves are attacked, the tree is not killed, but there is a possibility of the abnormal development of lateral shoots from the affected branches. On ornamental trees the injury caused to the foliage is decidedly detrimental. In Connecticut the insect attacks gray, white, and European white birches. It has never been observed on the yellow or the black birch.

It is very difficult to kill the larvae in the mines, but in the insecticide tests that have been conducted nicotine sulfate gives promise of being an efficient ovicide. Applications of this material, either with or without soap, in concentrations as low as 1–1500 in water, have killed between 90 per cent and 100 per cent of the eggs. These results have been attained when using cut twigs in the laboratory and when spraying the tops of individual birch trees in the field. Further field experiments will be conducted to determine the efficiency of this insecticide in protecting the trees throughout the season. In Tables 1 to 3 are given the results of some of the tests carried out to date.

The results given in Table 1 were obtained from cut twigs sprayed in the laboratory and kept in jars of water eight days. The eggs in the unsprayed twigs had all hatched in five days. The length of the egg stage was determined at this time as about seven days. The nicotine sulfate contained 40 per cent nicotine, and the soap used was a neutral powder sold for household purposes and containing 9.25 per cent moisture and 62.89 per cent soap, much of the remainder being sodium silicate (21.67 per cent). In view of the fact that Penetrol is claimed to have properties which prevent the rapid volatilization of nicotine, it was considered that the addition of this material might improve the ovicidal properties of the nicotine sulfate. The difference between the results attained with nicotine sulfate at 1–700 and nicotine sulfate at 1–800 plus Penetrol were not great enough to be significant. The soap content was by weight and the Penetrol content by volume. The pyrethrum soap material was a commercial brand containing 67 per cent inert ingredients, including water. This pyrethrum compound was much inferior to nicotine at the dilutions used.

In Table 2 are the results obtained from sprayed sprouts in the field. The eggs were marked before the leaves were sprayed in order to eliminate confusion with eggs laid after spraying was completed. The number of eggs in some cases is small, but the results are similar to those of

the following experiment. All the materials used gave satisfactory results, even when the nicotine was diluted 1–1500. The addition of Penetrol apparently improved the ovicidal properties slightly.

In Table 3 the nicotine sulfate was diluted as high as 1–2000 in an effort to determine how concentrated this material must be to be effective. No determination of the number of eggs present when the leaves were sprayed was made, and of course the adult insects were permitted to oviposit in the leaves after spraying was completed. A period of eight days was allowed to elapse because the normal egg period was at this time about seven days. The relative effectiveness of the treatment is shown by the number of eggs hatched per leaf, and the check leaves show the average expected hatch per leaf. Some of the eggs recorded as hatching may have been laid the day after the leaves were sprayed, but the table shows that this was not very extensive in four of the lots at least. The addition of Penetrol in this case apparently lessened the ovicidal properties of the nicotine somewhat.

In order to protect birch trees (not sprouts growing from a stump) it is necessary to spray for the first two generations. If the experiments conducted to date can be used as an indication of control measures to be adopted, then five sprays would be necessary for New Haven conditions, three one week apart beginning about May 20th, and two one week apart beginning about June 30th. Further field trials will be necessary to definitely ascertain the value of such spraying.

TABLE 1. *Fenusa pumila* CONTROL

Insecticide	Sprayed	Total Eggs	Eggs Hatched 7–30	7–31	8–1	8–2	8–3	8–4	8–5	8–6	Total	Per cent Dead
Nic. sulf. 1–600	7–29–30	66	0	4	1	0	0	0	0	0	5	92.4
Nic. sulf. 1–700	7–29–30	173	0	3	1	2	0	0	0	0	6	96.5
Nic. sulf. 1–600 +soap 0.8%	7–29–30	84	0	8	1	0	0	0	0	0	9	89.3
Soap 0.8%	7–29–30	81	0	8	38	14	11	2	0	0	73	10.0
Nic. sulf. 1–500 + penetrol 0.5%	7–29–30	42	0	0	0	0	0	0	0	0	0	100.0
Nic. sulf. 1–600 +penetrol 0.5%	7–29–30	83	0	0	1	0	0	0	0	0	1	98.8
Nic. sulf. 1–700 +penetrol 0.5%	7–29–30	68	0	12	1	0	0	0	0	0	13	80.9
Nic. sulf. 1–800 +penetrol 0.5%	7–29–30	96	0	0	0	0	0	0	0	0	0	100.0
Pyrethrum-soap 1–500	7–29–30	158	9	20	5	20	11	1	0	0	66	58.2
Pyrethrum-soap 1–600	7–29–30	132	0	37	26	14	18	0	0	0	95	2.80
Check	—	225	29	55	49	18	10	1	0	0	162	28.0

TABLE 2. *Fenusa pumila* CONTROL

Insecticide	Sprayed	Total Eggs	Eggs Hatched 8-22	8-24	8-25	8-27	Total	Per cent Dead
Nic. sulf. 1-800	8-19-30	52	0	0	0	0	0	100
Nic sulf. 1-1000	8-19-30	44	0	1	0	2	3	93
Nic. sulf. 1-1500	8-19-30	56	0	0	2	2	4	93
Nic. sulf. 1-800+penetrol 0.5%	8-19-30	58	0	0	0	0	0	100
Nic. sulf. 1-1000+penetrol 0.5%	8-19-30	56	0	0	0	0	0	100
Nic. sulf. 1-1500+penetrol 0.5%	8-19-30	56	3	0	0	2	5	91
Nic. sulf. 1-800+soap 0.8%	8-19-30	42	0	1	2	1	4	90
Nic. sulf. 1-1000+soap 0.8%	8-19-30	23	2	0	0	0	2	96
Nic. sulf. 1-1500+soap 0.8%	8-19-30	39	0	3	0	0	3	92
Check	—	55	5	7	11	12	35	36

TABLE 3. *Fenusa pumila* CONTROL

Insecticide	Sprayed	No. of Leaves	Eggs Hatched 8-27	8-29	8-31	9-2	Total	Hatched per Leaf
Nic. sulf. 1-1000	8-25-30	9	0	0	0	1	1	0.11
Nic. sulf. 1-1500	8-25-30	9	3	0	1	2	6	0.66
Nic. sulf. 1-2000	8-25-30	10	0	17	12	14	43	4.30
Nic. sulf. 1-1000+soap 0.4%	8-25-30	11	0	0	0	0	0	0.00
Nic. sulf. 1-1500+soap 0.4%	8-25-30	9	0	0	1	2	3	0.33
Nic. sulf. 1-2000+soap 0.4%	8-25-30	8	6	7	8	7	28	3.50
Nic. sulf. 1-1000+penetrol 0.5%	8-25-30	10	0	2	6	18	26	2 60
Nic. sulf. 1-1500+penetrol 0.5%	8-25-30	11	1	9	9	32	51	4.55
Nic. sulf. 1-2000+penetrol 0.5%	8-25-30	12	0	1	3	11	15	1.25
Check	—	26	0	42	62	130	234	9.00

LEAFHOPPER STUDIES DURING 1930

By W. J. SCHOENE, *Entomologist Virginia Agricultural Experiment Station*

ABSTRACT

Effect of severe drouth on apple leafhoppers was observed. The three species of *Erythroneura* were practically absent during the early summer, but gradually increased in numbers as the season advanced. The severe drouth shortened the life of *T. pomaria* first brood adults in some sections and the second brood did not develop into injurious numbers.

The leafhopper studies were continued during the past summer as described last year.[1] The insects were reared in cages in the insectary and greenhouse, and observations were made at intervals in the commer-

[1]Schoene, W. J., 1930. Jr. Ec. Ent. 23: 177-181.

cial orchard sections. Of special interest during the past season was the opportunity to study the effect of the severe and prolonged drouth on the leafhopper population. While the shortage of rain was general in the orchard sections, some trees were more favorably situated than others. Also, a few orchards were partially irrigated. It was thus pos-

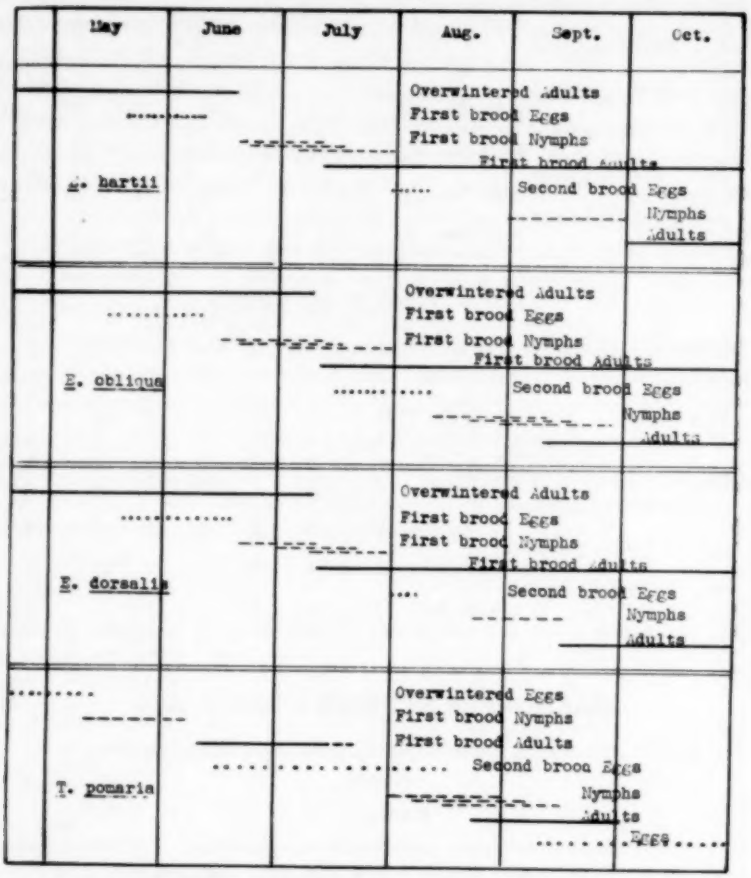


FIG. 5—Life History of *Erythroneura hartii*, *E. dorsalis*, *E. obliqua*, and *T. pomaria* at Blacksburg, Virginia, 1930.

sible to compare the leafhopper development under somewhat different moisture conditions. In the insectary the leafhoppers were obviously not affected by the drouth. It is probable that they were influenced by the high summer temperature. Four species, *E. hartii*, *E. obliqua*, *E. dorsalis*, and *T. pomaria*, were reared in the insectary and greenhouse. These life history records are shown in Figure 5.

LIFE HISTORY STUDIES:—The leafhoppers were reared on small apple trees planted in pots and enclosed with lantern globes. By comparing the life history this year with the data secured last season, some slight differences were noted. The period during which eggs were being deposited was much shorter in 1930 than in 1929. This difference might have been due to the temperature. During 1930, the temperature was higher by several degrees than in the previous season. All of the first brood nymphs in the insectary matured by August 1, this year, whereas, in 1929 the first brood nymphs of *E. obliqua* were present until August 15 and nymphs of *E. dorsalis* until September 5. The life history of all three species of *Erythroneura* during both years was similar in that a partial second brood was produced. This was true of the individuals reared in the insectary. During 1930, the cages were divided, some being located in the insectary and some in the greenhouse. The *Erythroneura* in the greenhouse produced no second brood. A discussion of the life history of the leafhoppers in the greenhouse will be left until another time. Attention is directed to the life history of *T. pomaria* as observed in the insectary. It will be noted that first brood adults were present from June 10 to July 15, and second brood adults from August 20 to October 5. This resembles the life history as observed by Lathrop[2] in the Hudson Valley. The incubation period of eggs deposited in June in some instances lasted 50 days.

FIELD OBSERVATION:—The three species of *Erythroneura* were practically absent until September. In May individuals were so hard to find that diligent search in a number of orchards was necessary to secure adults for life history work. During midsummer few adults were present and these were obscured by the more abundant *T. pomaria*, but during September their numbers began to increase and by the last of October *E. obliqua* was very numerous in some orchards.

The first adults of *T. pomaria* were observed about June 1 in the central part of the State and were generally present in considerable numbers by June 10. By this time the drouth was beginning to have its effect, and by June 25 the infestation by *T. pomaria* was noticeably affected. In the orchards that suffered most from the lack of rain the foliage had a dried appearance, very few leafhoppers, and no serious injury. Where trees were located on low land the leafhoppers were present in numbers until the first part of July and injury to the foliage was generally serious. Apparently the first brood adults lived for several weeks longer on trees that were favorably situated with reference to moisture. The first

[2]Lathrop, F. H. 1918. Jr. Ec. Ent. 11: 144–148.

second brood nymphs were observed on July 31, and were present in considerable numbers by August 25. An average of five nymphs to a leaf was observed in several orchards. Serious injury by the second brood nymphs and adults occurred in only a few orchards.

There were a number of orchards that were partially irrigated, after the drouth set in, but the application of water in midseason did not seem to affect the infestation by the second brood.

CONCLUSION:—It appears that, generally speaking, dry weather is favorable to leafhoppers but the extreme drouth of the past season had an unfavorable influence on the first brood of *T. pomaria* and that the adult life and egg laying period was shortened. Only in certain trees or sections that were favorably situated did the first brood deposit sufficient eggs to produce an injurious second brood. The three species of *Erythroneura* were present in very small numbers until September when they became very numerous. In October the *Erythroneura* greatly outnumbered *T. pomaria*.

THE CRANBERRY ROOTWORM AS AN APPLE PEST

By S. W. HARMAN, *New York Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

The habits of the cranberry rootworm (*Rhabdopterus picipes* Oliv.) are considered with reference to its status as an apple pest. The beetles at times cause considerable damage to the apple crop in certain sections, rendering it unfit for sale except to the canner or evaporator. Thoro spraying with lead arsenate has afforded effective protection.

The cranberry rootworm (*Rhabdopterus picipes* Oliv.) is widely distributed over the United States. It is primarily a pest of the cranberry, feeding largely on the roots. The adult or beetle attacks the fruit and foliage of the cranberry, and it is this stage that feeds on the apple. The species has attracted attention in western New York, more especially in Wayne county, for a number of years past. Nearly every season reports reach us of damage of varying extent in apple plantings. During 1928, one grower stated that 70 per cent of his Ben Davis apples had been scarred by the pest. Fruits injured by the beetle are rendered unfit for marketing except for canning or evaporated stock.

LIFE HISTORY. *Larva.* The larva of the cranberry rootworm beetle is whitish in color with a brown head and is usually found lying in a curved position in the soil. When full grown the larva measures 5/16 of an inch in length. They feed on the roots of sod and other plants growing beneath the trees in the orchard, and about ten months of the year are

The cranberry rootworm beetle, *Rhabdopterus picipes* Oliv.
Top—Adult enlarged and natural size
Below—Injury to apples

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spent in this stage. For purposes of hibernation the larvae burrow deeper in the soil, while later on during May they are found just beneath the surface where they pupate.

Pupa. The pupal form occurs in June. This stage is white and very susceptible to handling. The pupa is slightly shorter than the full grown larva.

Beetle. The adult or beetle measures about 7/32 of an inch or slightly less than ¼ of an inch in length. The beetles are a shiny, metallic-green color and are found in the orchards for a period of about four weeks during June and July. Eggs are laid just beneath the surface of the soil or on litter on the ground.

Host Plants. The beetle is a general feeder and has been observed damaging the foliage, and in many cases the fruits of the following plants: apple, blackberry, basswood, cherry (sweet, sour, wild black cherry, and pin cherry), cranberry, dock, dogwood, elm, grape (wild and cultivated), maple leafed arrow-wood, myrtle, pear, plum, red raspberry, rose, strawberry, swamp blueberry, and woodbine.

Injury. During June and July the beetles attack the fruit and foliage of the apple. On the fruit the feeding scars are narrow and shallow cuts of variable length thru the skin and extending into the flesh. The scars developing from the initial injuries are irregular, forming figures of varying design. Ben Davis and Greenings appear to be two of the more susceptible varieties. Injury on Ben Davis often heals in the form of swellings, while Greening retains more of the original appearance of the injury.

Damage to foliage consists of narrow, irregular cuts somewhat similar to the scars on the fruits. Practically all cases of injury observed by the writer have occurred in sod orchards, and the light, sandy type of soils appear to be favored by the beetles.

Control. Up to the time this investigation was undertaken little was known regarding the susceptibility of the insect to spray practices adapted to the treatment of apple orchards, and for that reason special efforts were made to determine a satisfactory method of control.

Lead arsenate proved to be the most effective insecticide tested, and the following table gives the more important data taken from an experimental Ben Davis orchard at Red Creek, New York.

Observations made over a period of years show that the beetles appear in large numbers within a few days time and commence feeding immediately. A crop may be clean and uninjured on one day, while a few days later the same orchard will reveal the feeding scars of the beetles on a

CRANBERRY ROOTWORM BEETLE CONTROL DURING 1930 AT RED CREEK, N. Y.

Materials and Rates per 100 Gallons	Dates of Applications		Number of Apples Counted	Per cent Injury
Lead arsenate 6 lbs., fish oil 1 qt	June 11	June 23	4828	2.1
Lead arsenate 3 lbs., fish oil 1 qt	June 11	June 23	7213	3.9
Lead arsenate 3 lbs., dry mix	June 11	June 23	7552	2.8
Lead arsenate 3 lbs., dry mix, fish oil 1 qt	June 11	June 23	6020	5.4
Hydrated lime 30 lbs., kayso 1 lb	June 11	June 23	8714	10.0
Lead arsenate 3 lbs., bordeaux 1–6–50	June 11	———	8475	14.2
Lead arsenate 3 lbs., dry mix, fish oil 1 qt	June 11	———	8684	19.5
Lead arsenate 2½ lbs., hydrated lime 15 lbs., lime-sulfur 1–40	June 11	———	8129	32.1
Lead arsenate 6 lbs., fish oil 1 qt., lime-sulfur 1–40	June 11	———	5668	1.7
Lead arsenate 5 lbs., dry mix	June 9	———	3867	2.4
Checks, no treatment since the calyx	———	———	18014	37.3

large percentage of the fruit. Therefore, to combat the pest satisfactorily, spray applications should be made to the trees as soon as there is evidence of the emergence of the beetles.

On June 11 when the first application was made approximately 50 per cent of the larvae had entered the pupal stage. By spraying on this date a few days leeway were allowed before the beetles appeared on the 16th. The second application followed in twelve days, at which time the beetles were most numerous. Two applications of three pounds of lead arsenate gave satisfactory control. Generally speaking, one application of three pounds of lead arsenate was inadequate; however one application of six pounds gave a high degree of protection.

The regular spray schedule in use in western New York specifies that the first cover spray for the codling moth be made approximately four weeks after the calyx period. The cranberry beetle injury appears about the third week after the calyx application, so that for adequate protection where both pests are important it may be necessary to make one additional spray timed with referenced to the development of the cranberry rootworm beetle and followed by a second application corresponding with the first codling moth spray.

Thursday Afternoon, November 20, 1930

INFLUENCE OF PLANTING DATES OF SWEET CORN ON EUROPEAN CORN BORER INFESTATION

By G. E. R. HERVEY and F. Z. HARTZELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Methods followed and results obtained are here given for experiments dealing with the time of planting sweet corn in relation to corn borer (*Pyrausta nubilalis* Hubn.) infestation in central and western New York. The Latin Square arrangement of plats was used with five planting dates and five replications. The data secured were subjected to biometrical analysis. The results indicate that the time of planting has an important influence on the corn borer infestation.

Previous experiences have indicated that the time of planting sweet corn bears an important relation to the rate of corn borer infestation (1, 2). The experiments outlined in this paper were undertaken with the object of determining the approximate dates, in various canning areas in western New York, when sweet corn can be planted to escape serious losses by the insect and still mature before the danger of frost injury becomes imminent. This information should have considerable practical value to the farmer and the canner because it seems to be the only opportunity the individual has of coping with this problem at the present time. While the disposal of infested stalks by plowing and other means when conducted on a community basis is without doubt an effective measure against the insect, isolated efforts along this line have little or no value. The preliminary nature of these experiments and the light, scattered infestation in New York this season, especially in the localities where the experiments were conducted, tends to render the results indicative rather than significant. The field experiments and corn borer studies were made by the senior author, while the responsibility for the biometrical aspects rests with the junior author.

DESCRIPTION OF EXPERIMENTS. Four experiments were conducted during the season of 1930 and they were located at the following places: Sheridan in Chautauqua county, Brockport in Monroe county, Mt. Morris in Livingston county, and Geneva in Ontario county. As shown in Figure 6, the experiments were located with the idea of placing them in the main sweet corn canning and market garden areas and at the same time have different environmental complexes. The tests at Sheridan and Brockport were situated on the Erie and Ontario plains and were on soils typical of these areas. Mt. Morris is typical of the river valley soils, and Geneva is representative of the upland farming region of

western New York. Previous to this season the areas where canning factory corn is grown in Onondaga, Oneida, Madison, and Oswego counties had shown practically no infestation and were not included when the tests were arranged.

In the case of the experiments situated at Mt. Morris and Geneva only three planting dates were used. This was owing to weather and soil conditions in these localities. The earliest average planting date in these

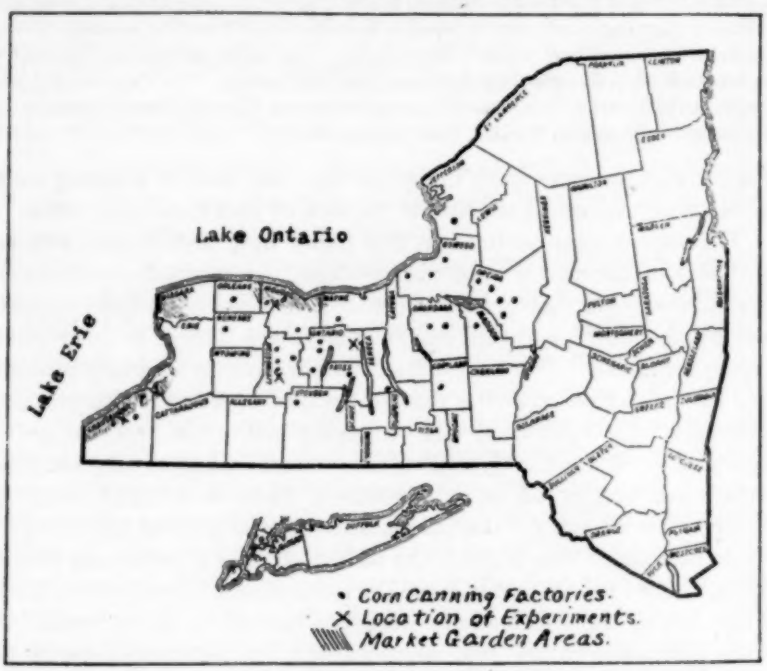

FIG. 6.—Outline map of New York showing distribution of canning factories which were packing corn in 1926; market garden areas and location of experiments.

areas is between May 20 and June 1, and this season it was impossible to plant before the end of May. The experiment at Mt. Morris was situated on Genesee silt loam with an elevation of 570 feet. This is a very heavy soil and well adapted to growing canning crops, such as corn. The planting dates in this test were May 31, June 2, and June 12. Owing to the small number of planting dates in this experiment the Latin Square method of arrangement of plats was not followed as in the case of the tests at Sheridan and Brockport. Records from the plats showed only one infested hill from all three plantings, so it is not necessary to analyze the data by biometrical methods.

The experiment at Geneva was situated on Dunkirk silty clay loam with an elevation of 580 feet. As in case of the test at Mt. Morris the condition of the soil prevented making more than three plantings. The first planting made May 12 developed slowly owing to cold weather and the second was not made until June 3. The third was made June 7. Records from the experiment showed only two infested hills.

Experiment 1 was located at Sheridan, approximately one and one-half miles from Lake Erie. The soil is mapped as Dunkirk gravelly loam, with a general northwest slope and an elevation of 760 feet. The plats were five rows wide and twelve hills long, making approximately one-eightieth of an acre. Golden Bantam was used in this experiment, as this variety is the one most widely grown in western New York. Plantings were made at five different dates at approximately ten-day intervals, and on each date the planting was replicated five times. In order to overcome as much as possible the variation in infestation and soil heterogeniety the Latin Square method of arrangement of plats was used. The arrangement of plats for this experiment is shown in Chart 1. The arrangement of the plats in Experiment 2 is very similar. The results of Experiment 1 are shown in Table 1.

CHART 1. ARRANGEMENT OF PLATS FOR EXPERIMENT 1 AND THE AVERAGE NUMBER OF BORERS PER PLANT IN EACH PLAT

I .13	II .33	III .16	IV .15	V 0
II 1.19	IV .52	V .34	III .09	I .23
IV .08	III .57	I .21	V .23	II 1.00
V 0	I .14	IV .17	II .42	III .10
III .44	V .07	II .63	I .25	IV .08

TABLE 1. SHOWING THE PLANTING DATES AND THE RESULTS OBTAINED FROM EXPERIMENT 1 AT SHERIDAN

Series Number	Date Planted	Number Plants Examined	Number Borers Found	Average Number Borers per pl.
I	May 2	137	26	.20 ±.04
II	May 12	139	105	.76 ±.11
III	May 21	147	38	.26 ±.04
IV	June 3	128	27	.21 ±.04
V	June 11	138	12	.13 ±.03

Experiment 2 was located at Brockport, about ten and one-half miles from Lake Ontario. The soil is Ontario fine sandy loam with a gentle north slope and an elevation of 540 feet. The other features of the test are the same as for Experiment 1. The two experiments were situated about ninety miles apart and in areas where the corn borer has been most prevalent in New York. The planting dates at Sheridan preceded those at Brockport from one to six days on account of soil and weather conditions. The results from Experiment 2 are shown in Table 2.

TABLE 2. SHOWING THE PLANTING DATES AND RESULTS OBTAINED FROM EXPERIMENT 2 AT BROCKPORT

Series Number	Date Planted	Number Plants Examined	Number Borers Found	Average Number Borers per Plant
I.....	May 5	156	148	.92 ±.10
II.....	May 17	146	34	.27 ±.05
III	May 27	146	48	.33 ±.06
IV.....	June 6	132	8	.06 ±.02
V.....	June 12	156	3	.02 ±.01

The records from the experiments were taken as soon as the corn reached the edible stage and before it was likely that any migration of the larvae had taken place. In order to overcome border effects the outside row of each plat was discarded giving two buffer rows between the parts of the plats which were counted. From the thirty hills remaining in the plat ten were selected from which the records were taken. This gave an average of approximately twenty-seven plants for each plat. The hills to be counted were selected by taking hills 3, 7, 10 from the first row; 2, 4, 6, 8 from the second row, and 1, 5, 9 from the third row. The hills were pulled up, the plants dissected and the number of larvae recorded. The plant in this case is construed to mean the stalk. the ears and the suckers.

BIOMETRICAL ASPECTS OF THE EXPERIMENTS. As stated above the Latin Square arrangement of plats was used in order to overcome heterogeneity in infestation and soil where a sufficient number of planting dates to give five replications could be made. As shown by Hartzell (3), this arrangement compensates for heterogeneity if the variation from plat to plat would have occurred by approximately equal differences had all plats received the same treatment. Studies of the corn borer has shown that this condition generally holds, therefore the system is applicable to this study. The usual method of computing variance is by using the plat as the unit. With five treatments (dates of planting) each replicated five times, the use of the plat as a unit gives values for variance so large that the results are not significant. For several reasons, chief of which is the fact that the number of plants examined in each plat varied,

it seems better to make the plant the unit and to take the mean of all plants receiving the same treatment. In addition to giving a better "sample" for each treatment, the Latin Square makes possible the calculation of intraclass variation, thereby giving significant differences between treatments where the ordinary formula being incorrect might give odds considerably below 30 to 1. Intraclass correlation has been computed from the equation of Harris as given by Fisher (4).

$kS\,(\bar{x}_p - x_p)^2 = n's^2\left\{1 + (1-k)\,r\right\}$ which may be expressed

$kn\sigma_t^2 = n\sigma_p^2\left\{1 + (1-k)\,r\right\}$ where

k = number of replications, σ_t = standard deviation of the means of the treatments, n = number of treatments, σ_p = standard deviation of means of all plats, and r = intraclass correlation. Solving for r, the equation is

$$r = \frac{k\sigma_t^2 - \sigma_p^2}{\sigma_p^2\,(1-k)}.$$

The standard deviation of the difference between two plats was computed from the equation $\sigma_d^2 = \sigma_a^2 + \sigma_b^2 - 2\sigma_a\,\sigma_b\,r$ where σ_d = standard deviation of the difference, σ_a = standard deviation of one plat, and σ_b = standard deviation of other plat. The probable error of the difference is given by the equation $E_d = .6745\,\sigma_d$

In calculating, the quantities were carried to four decimal places, but in the tables these have been rounded off to two decimal places.

Attention is called to the fact that a difference in infestation between two series of plats, planted at different dates, is not considered significant unless the difference is 3.17 (or greater) times its probable error. In other words the odds should at least be 30 to 1 that the result is not due to normal variation before the difference is regarded as having been caused by variation in the time of planting. The differences in infestation between the several series of plats in the same experiment, together with their probable errors are given in Tables 3 and 4.

TABLE 3. DIFFERENCES BETWEEN PLANTING DATES AND THEIR SIGNIFICANCE FOR EXPERIMENT 1. INTRACLASS CORRELATION + .42

Plats	Differences	Diff. / P. E.	Odds
1–5	.07 ±.04	1.90	4.0 to 1
2–1	.55 ±.10	5.45	4169 to 1
2–3	.50 ±.10	4.92	1078 to 1
2–4	.54 ±.10	5.39	3583 to 1
2–5	.63 ±.10	6.15	29585 to 1
3–1	.05 ±.04	1.32	1.7 to 1
3–4	.05 ±.04	1.12	1.2 to 1
3–5	.13 ±.04	3.29	37 to 1
4–1	.01 ±.04	.16	0.1 to 1
4–5	.08 ±.04	2.01	4.7 to 1

TABLE 4. DIFFERENCES BETWEEN PLANTING DATES AND THEIR SIGNIFICANCE FOR EXPERIMENT 2. INTRACLASS CORRELATION + .50

Plats	Differences	Diff. / P. E.	Odds
1–2	.65 ±.09	7.47	2,125,000 to 1
1–3	.59 ±.09	6.77	66,900 to 1
1–4	.86 ±.09	9.36	>300,000,000 to 1
1–5	.90 ±.10	9.20	>300,000,000 to 1
2–4	.21 ±.04	4.79	1000 to 1
2–5	.25 ±.05	5.54	5460 to 1
3–2	.06 ±.05	1.10	1.2 to 1
3–4	.27 ±.05	5.43	3960 to 1
3–5	.31 ±.05	5.94	16,025 to 1
4–5	.04 ±.02	2.50	8.1 to 1

CONCLUSIONS. These tests indicate that there is a certain stage in the growth of Golden Bantam sweet corn when it is most susceptible to corn-borer attack. In general, early planted sweet-corn is more heavily infested than that planted later and the differences become greater as the dates of planting are more widely separated. However, in one experiment the corn first planted seems to have developed beyond the susceptible stage by the time the corn borer made its attack, as shown in Table 1.

A comparison between infestation and planting dates would seem to indicate that, at least during 1930, corn planted in light soils was more seriously attacked because it was put in the ground earlier than was corn on heavy soils; so perhaps the effects were not caused by other edaphic factors.

It would appear, for this season at least, that Golden Bantam sweet corn planted June 1 or later would escape serious infestation in the localities mentioned above. There is also the possibility that corn planted very early on light soils will pass the susceptible stage before oviposition takes place.

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THE PRESENT STATUS OF CARROT RUST FLY CONTROL IN NEW YORK

By HUGH GLASGOW, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Injury by the carrot rust fly, *Psila rosae*, may be prevented or greatly reduced by regulating the planting and harvesting dates so that the growing period falls in the interval between the first and second broods of the insect.

This maggot-free period may be further extended by repeated applications of naphthalene, commencing when the flies of the second generation begin to appear and continuing to approximately one month of the proposed harvesting date.

In the period preceding the appearance of the rust fly in this country few vegetables were less subject to attack by serious insect pests than the carrot. After the introduction of the insect this situation quickly changed and the rust fly has now become, in many localities at least, the chief factor limiting the growing of this vegetable.

The history of the rust fly in New York has been that as it invades a new section it gradually builds up in numbers over a period of years until the production of marketable carrots, or of any carrots at all in some of the more intensive vegetable growing districts, has become increasingly difficult.

In some sections of the state where carrots were formerly grown intensively they have had to be abandoned as a commercial crop and are seldom grown even in home gardens. The reason for this consistent increase in the insect appears to be due in part to a surprising dearth of natural enemies, and particularly to the system of cropping frequently followed where early and late plantings of carrots or celery are grown in the same general locality.

The insect is multi-brooded and, being exceedingly prolific, such a system of cropping is peculiarly favorable to its rapid increase. In fact, if the primary objective of the grower were to propagate the insect instead of these crops, it would be difficult to work out a more effective scheme than that followed in many communities.

There are two clearly defined broods of the rust fly that must be taken into account in any consideration of control measures.

The flies of the overwintering generation commonly begin to appear from the middle to the latter part of May, while adults of the second generation do not commence to emerge as a rule until nearly two months later or until towards the latter part of July.

As things work out in practice the first brood, which may have been greatly depleted in numbers during hibernation, finds an abundant supply of food in early plantings of carrots or celery on which to multiply.

As a result of such a timely and abundant source of food, the insect is enabled to increase greatly in numbers so that the second brood of flies appearing the latter part of July may be present in overwhelming numbers ready to attack the main crop coming on later in the season. In such a case the main crop naturally suffers the brunt of the attack, altho sometimes even the early plantings may be completely destroyed by the first brood.

From this brief outline of the seasonal history of the insect in its realtion to the crops commonly attacked, the importance of eliminating all early plantings of its favorite host crops should be perfectly apparent. By such a procedure and by delaying the planting of the main crop of carrots until early in June, it has frequently been possible to get rid of the insect almost entirely in a single season by the simple process of starving the first brood. While this is without question one of the simplest and most economical means of avoiding rust fly injury to carrots, it is very often difficult, if not impossible, to get the degree of cooperation necessary to make such a method effective. Where it is not possible to carry out such a program, the alternative is to defer planting the main crop until after the first of June and plan to harvest by the first to the middle of September. By such a procedure the carrots escape first-brood injury almost entirely since the first-brood flies will have largely disappeared before the young plants are large enough to attract them for oviposition. If such a late planted crop is harvested before second brood injury appears, which in New York is sometime around the first of September, it should escape serious injury. During most seasons when growing conditions are at all favorable it is possible to secure a satisfactory yield of clean carrots by this method. In fact, this is the method of control that has been the chief reliance of our growers for the past three or four seasons, and has been the only method by which the growers have been able to produce clean carrots in some communities.

While such a procedure, if followed consistently, does insure a reasonable yield and almost complete freedom from injury, it limits the growing season in badly infested sections to from three to three and a half months. Unless growing conditions are exceptionally favorable it is hardly possible in this period to secure either a full yield or carrots of maximum size and it has the further weakness that the crop must be harvested at a specified time irrespective of the convenience of the grower or the condition of the market.

A large part of the carrots produced in New York are grown either for the canners or for the makers of condensed soups. For this purpose it is desirable that they reach maximum size before being harvested in order

to minimize the wastage during the course of preparation at the factory as well as to provide for the greatest possible return to the grower.

The most obvious means of accomplishing this is by extending the maggot-free growing period beyond its present rather narrow limits thru the use of insecticides. In an attempt to accomplish this various materials have been tested. A few of these, such as mercurous chloride, have shown an appreciable degree of control and should prove useful in small plantings or in the home garden. Practically all the materials tested, however, were found either too expensive for use on a large scale or were too apt to damage the crop when used at concentrations sufficient to give control. A notable exception was in the case of naphthalene. This material, even when applied in excessive amounts, failed to produce any noticeable injury to the growing plants, while it was found possible by its use to extend the growing season from one to two months without seriously increasing the danger of maggot injury.

By drilling naphthalene along the carrot row at the rate of several hundred pounds per acre it has been found possible to greatly lessen rust fly injury, altho the degree of control secured by this method of application has never been uniform enough to warrant its use on a commercial scale. When, however, the naphthalene is distributed evenly over the entire field at the same rate, the control as a rule has been much more consistent.

In tests carried out during the past season varying amounts of naphthalene were used ranging from several hundred pounds to as much as three tons per acre. Excessive amounts were used in some cases in an attempt to determine the tolerance of the carrot to this material, and it is of interest to note that even where as much as three tons were used per acre during the season no apparent injury resulted either to the foliage or as indicated by a reduction in yield. It should be noted, however, that care was taken to make the application only when the foliage was comparatively dry.

The particular experiment to be discussed here was located in a large muck area near South Lima, New York. Carrots were formerly grown extensively in this section, but owing to the ravages of the rust fly this vegetable has been almost completely abandoned as a commercial crop for a number of years. Early celery is still grown extensively and this crop, which is often severely damaged, serves as a reservoir in which the insect is able to maintain itself in maximum numbers. This locality was chosen for the experiment on account of the prevalence of the insect and the certainty that a heavy and uniform infestation could be counted on to develop later in the season from the second generation.

The carrots were seeded on June 1 in order to eliminate first-brood injury. On July 28 the second-brood flies commenced to appear in numbers and the treatments were accordingly started at this time.

The field was divided into tenth-acre plots and at harvesting time the records were taken from one square rod located in the center of each of these plots. The infestation proved to be uniformly heavy thruout the entire planting, practically every carrot in the untreated sections being attacked, individual carrots sometimes yielding as many as a hundred maggots each by the time the final records were taken.

Both crude and refined grades of naphthalene were used in the course of the work, but as crude naphthalene appeared to persist for a longer time in the soil and on the whole gave somewhat better control, this grade was used in the majority of the tests.

When used at the rate of 400 pounds per acre for each application the results were essentially the same as where heavier dosages were used, and for this reason only one series of tests where this amount was applied will be used in illustrating the results. The two plots from this test that are to be considered were treated as follows: The naphthalene was distributed by hand as uniformly as possible over the growing carrots at the rate of 400 pounds per acre for each application. The first was made on July 28 when the flies commenced to appear in numbers, and this was repeated at weekly intervals until a total of six applications were made in the case of Plot 1. On Plot 2 the last two were omitted, making a total of but four early applications in this case.

In this field rust fly injury commenced to appear in the untreated sections by August 30, and it was found necessary to harvest the bulk of the crop by September 2 to avoid serious damage. At this time approximately two per cent of the carrots in the untreated parts of the field showed evidence of rust fly attack and the injury was rapidly increasing. The remainder of the field, including an untreated check plot, was left until the middle of October when the final records were taken. In this check plot the infestation increased steadily after the first of September until, approximately three weeks after the first injury appeared, practically all the carrots were infested, some being almost completely honeycombed by the mines.

During the course of the season this field was visited regularly once a week. On September 16 the various plots presented much the same appearance to the casual observer. One week later, however, a very striking contrast had developed, for while the tops in the naphthalene treated plots were growing normally, those in the check plot were turning yellow and in most cases were flat on the ground as tho they had been

Naphthalene in Carrot Rust Fly control. Untreated checks above. Naphthalene treated block below. Note relative height of tops as indicated by stakes. Compare with following plate for yield.

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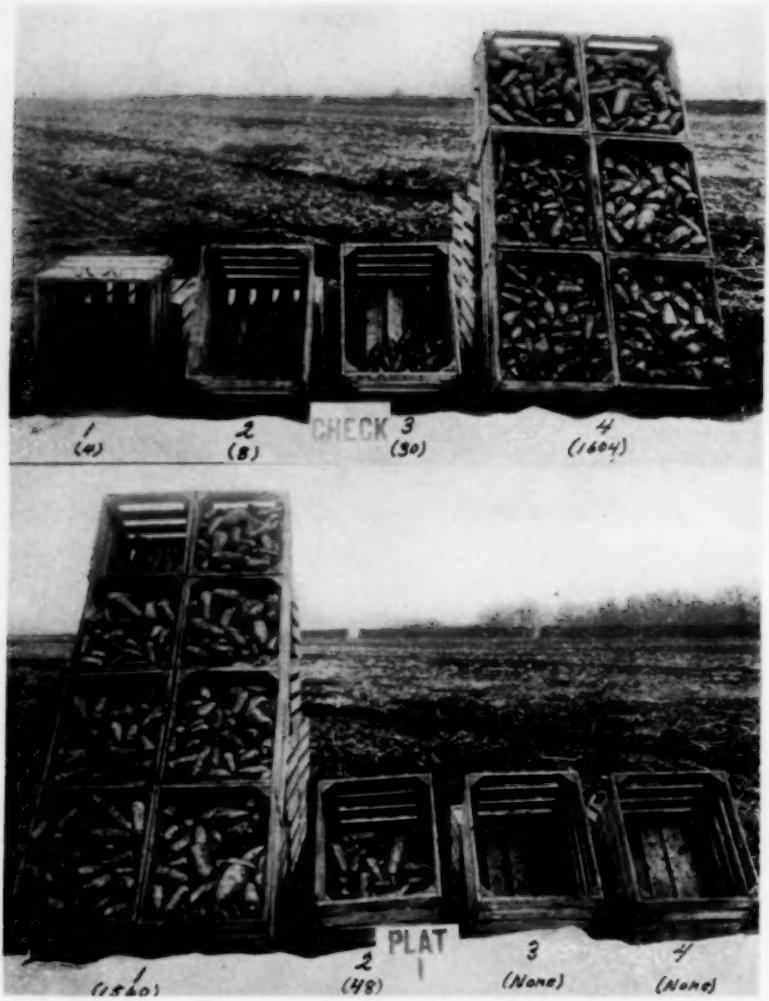


Untreated check above. Naphthalene treated plot below.

1, Carrots free from rust fly injury.
2, Slightly infested carrots.
3, Moderately infested carrots.
4, Badly infested carrots.

swept by a heavy wind. Some idea of this difference can be gained from the two photographs shown in Plate 4, altho the contrast is not nearly so striking here as it appeared in the field.

In the untreated block the infestation was so severe that with the almost complete destruction of the lateral roots, and in many cases the top roots as well, the tops were unable to maintain themselves and consequently collapsed. At the time the final records were taken this heavy loss of roots was even more noticeable and was particularly apparent from the ease with which the carrots in the check plot could be pulled.

For the purpose of the present discussion yield records from but three typical plots will be considered. These are summarized in Table 1. The yields from two of these plots, the check plot and the one receiving six weekly applications of naphthalene are shown as photographs in Plate 5, and in each case represent the carrots harvested from one square rod taken from the center of its respective plot. In these photographs the carrots free from rust-fly injury are grouped on the left as No. 1, while the three units on the right (two, three, and four) represent from left to right the light, moderate, and severely infested carrots from their respective plots. This classification is an arbitrary one adopted purely for convenience. In crates No. 2 are grouped the slightly infested carrots, those showing from one to three mines each. The moderately infested carrots in crate No. 3 were those showing from three to ten mines, while those classed as severe in division No. 4 represent all those having over ten mines. Many of those in this latter classification showed as many as 50 or 100 mines and were usually beginning to turn dark, particularly toward the tip. A careful study of these two photographs will give the reader an excellent idea of the striking contrast in amount and degree of rust-fly injury shown in these two plots at harvesting time.

From a study of Tables 1 and 2 it will be seen that periodical applications of naphthalene exert a marked influence in reducing the amount of carrot rust-fly injury. Six applications reduced the total injury from nearly 100 per cent in the untreated check to less than three per cent. Where but four applications were made the apparent reduction was not great since the total infestation in this case was 97 per cent. It should be noted here, however, that while the total infestation was nearly as great as in the check, the degree of injury was actually very much less than this.

When expressed graphically as in Table 2 it will be seen that six applications of naphthalene gave a total increase in yield amounting to over eight and one-half tons per acre. On the basis of actual clean, marketable carrots, however, this increase amounted to over 37 tons per acre at an expenditure of less than 1¼ tons of the naphthalene.

TABLE 1. INFLUENCE OF NAPHTHALENE IN CARROT RUST FLY CONTROL. YIELDS RECORDED FROM PLOTS OF 1 SQUARE ROD

Treatment	Total Number Harvested	Total Weight (pounds)	Uninjured Number	Uninjured Weight (pounds)	Infested Total Number	Infested Total Weight (pounds)	Infested Number Slight	Infested Number Moderate	Infested Number Severe	Percentage Free from Rust Fly Injury
Plot No. 1										
Naphthalene (6 applications)	1612	484	1564	468	48	16	48	none	none	97.64
Plot No. 2										
Naphthalene (4 applications)	1602	384	41	6	1561	377.75	400	681	480	2.56
Check	1646	377	4	0.12	1642	377	8	30	1604	0.25

TABLE 2. INFLUENCE OF NAPHTHALENE IN CARROT RUST FLY CONTROL. YIELDS RECORDED IN TABLE 1 REDUCED TO AN ACRE BASIS (TONS PER ACRE)

Treatment	Total Yield	Yield Clean Carrots	Yield Infested Carrots Total	Slight	Moderate	Severe	Total Increase Due to Treatment	Increase in Clean Carrots Due to Treatment
Naphthalene (6 applications)	38.7	37.44	1.3	1.3	0.0	0.0	8.6	37.43
Naphthalene (4 applications)	30.7	0.42	30.22	6.12	13.68	10.42	0.6	0.41
Check	30.1	0.01	30.09	0.16	0.0	29.93	—	—

While no attempt will be made here to formulate final recommendations for the use of naphthalene, the results of the experiments so far carried out do indicate that this material should prove an exceedingly useful insecticide in combating not only the carrot rust fly but possibly other similar soil inhabiting insect pests as well.

From our experience so far it is evident that naphthalene, to be effective against the rust fly, must be used as comparatively heavy and frequent applications. In this connection it should be noted that the work reported here was carried out under exceedingly difficult conditions, the infestation being exceptionally severe. In the case of more moderate infestations it will doubtless be found that less frequent and perhaps much lighter applications will give a satisfactory degree of control.

While the work with naphthalene so far carried out has been confined almost entirely to the second brood of the rust fly in an attempt to lengthen the maggot-free season for carrots, there is no apparent reason why it should not apply equally well as a means for protecting early plantings of this vegetable from attack by the first brood.

It also holds a great deal of promise for use on celery since there has, heretofore, been no satisfactory means of protecting this crop from the rust fly. In the case of celery it may be necessary to devise some means of distributing the naphthalene so that no great amount will come in contact with the leaves, since the foliage of this crop is much more subject to injury than that of carrots.

Crude naphthalene is comparatively cheap, costing in the neighborhood of forty dollars per ton in car lots. Even at this low price the expense of using this material for rust fly control, when applied in the amounts that appear necessary to give satisfactory results, is considerable. This cost, however, is not prohibitive, in many cases at least, when one considers the value of the crop involved and the degree of control that can evidently be secured even under very difficult conditions.

It has been noted by various workers that naphthalene appears to have a stimulating effect on the growth of certain plants.

In our preliminary work in testing naphthalene against the rust fly it was noticed that the carrots in the treated plots were uniformly larger and the yield appreciably greater than in the checks, even tho the rust fly control in many cases was far from perfect. This was so striking that at first it was felt it must be due to some direct stimulating action of the chemical on the growth of the plant. Later it became apparent that this supposed stimulation was really indirect, the presence of the naphthalene merely enabling the plant to grow more vigorously, thru lessening the destruction of the lateral feeding roots by the early stages of the maggot.

It seems not improbable also that some of the stimulating action noted in the case of other crops may be due in part to the naphthalene checking the activities of certain obscure animal or plant organisms in the soil that may exert to some degree an inhibiting action on plant growth. In this connection it might be mentioned that naphthalene appears to have some fungicidal value. Mr. W. O. Gloyer, in the course of preliminary laboratory tests with petri dish culture of Rhizoctonia, Fusarium, Rhizopus, Penicillium, etc., finds that a crystal 5 mm. square kills the mycelium of certain fungi while in other cases the vegetative growth was either inhibited or the mycelium grew at a reduced rate. Where a marked toxic action was found his observations were as follows:

"The growth was first retarded which was accompanied by increased flocculation of the cell contents. Next the cells became turgid until finally the cell wall burst and the contents was expelled with violence. These observations seem to justify further field tests along similar lines. It is hoped that in the care of special crops the presence of naphthalene for a short period may be found to afford sufficient fungicidal protection to enable the plant to escape infection during a critical period when it is most susceptible to a given parasite."

THE PEAR MIDGE

By F. G. MUNDINGER, *N. Y. Agricultural Experiment Station*

ABSTRACT

The pear midge, *Contarinia pyrivora* Riley, is a small mosquito-like fly, destructive to many varieties of pears in New York State, particularly in the Hudson Valley. The fly is probably of European origin. It was first discovered at Meriden, Conn., in the year 1877. From here it spread rapidly westward and by 1893 was reported in all river counties south of Saratoga and Washington.

The flies emerge in the spring about the time Kieffer fruit buds are breaking. The eggs are laid inside the individual clusterbuds and under favorable weather conditions hatch in about four days. The larvae find their way into the ovary of the future blossom and feed on the tender tissues, causing the young fruit to develop abnormally. The distorted shapes resulting from midge attack are very characteristic. The small fruits drop prematurely and the mature larvae burrow into the soil a short distance where pupation takes place over winter.

The studies so far indicate that the adults are very susceptible to certain spray treatments. These are most efficiently made when the cluster-buds have begun to swell so that the sepals pull apart. In Clapps the faintest trace of pink is apparent at this time. Lime-sulfur, 1–40 or stronger with ¾ pint of nicotine-sulfate per 100 gallons; Volck oil emulsion, 2% with ¾ pint nicotine-sulfate; bordo, 2–10–100 with 1 pint nicotine-sulfate and fish oil soap, 6 lbs., water 100 gallons, with ¾ pint of nicotine-sulfate have shown very promising results. Every part of the tree should be thoroly wetted including trunk and lower limbs so that all possible flies will be reached and killed.

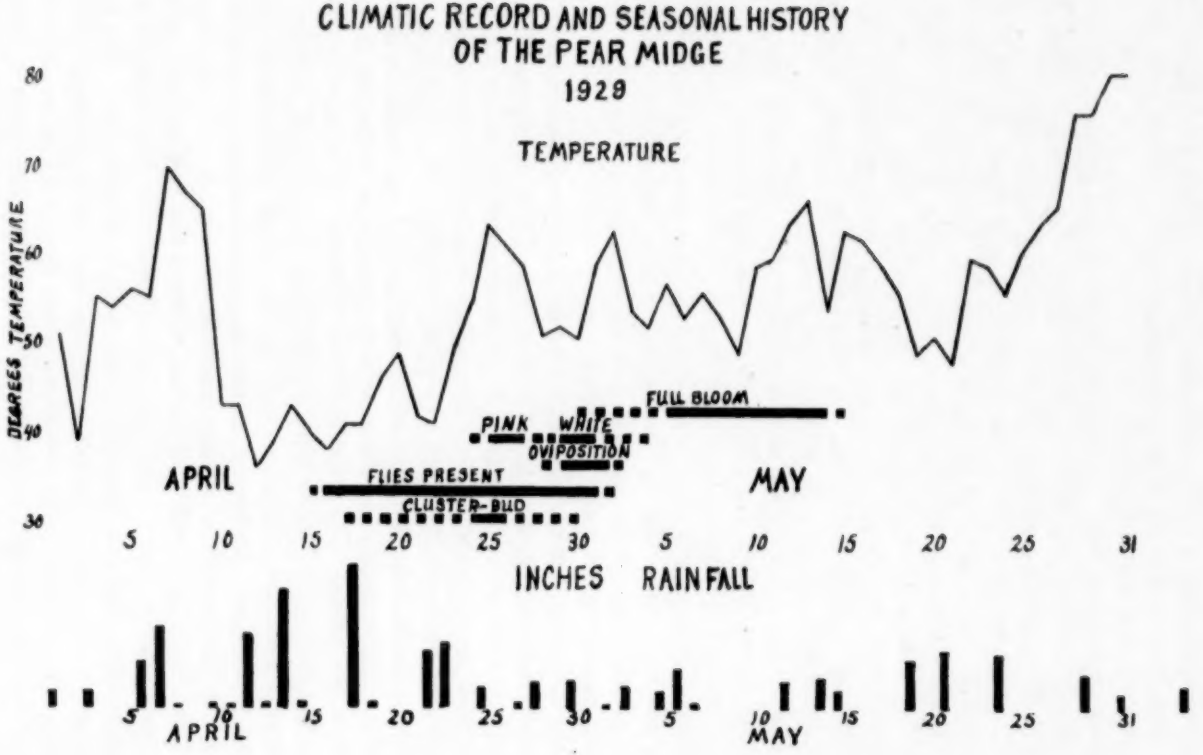
The pear midge, *Contarinia pyrivora* Riley, is a serious pest of pears in the Hudson Valley and in some other regions of New York State. The fly first known by some writers generically as Cecidomyia and later as Diplosis was finally redescribed and renamed by Dr. C. V. Riley, *Contarinia pyrivora* in 1891. Its position in the general group of gall flies is strikingly brought to mind on examination of a young infested pear which is eventually converted into an empty gall by the insect.

The pest was brought to this country on pear stock, probably from France in 1877, and was first discovered in Lawrence pears in Coe Brothers' orchard, Meriden, Conn. From here it spread to other orchards. Many pear plantings in the Hudson Valley have suffered severely from its attacks, the loss in harvested fruit reaching as high as 98 per cent in some instances. The insect may also be found in destructive numbers in central and western New York.

The principal varieties attacked are Lawrence, Keiffer, Clapp, Bartlett, D'Anjou, Seckel, etc. The flies are small and mosquito-like, measuring about 3 millimeters over all in length. The general body color is brown. The head is bent strongly ventrad. It is concave anteriorly and the antennae, especially of the males, are very long, moniliform, and clothed with whorls of hairs. The legs also are long and slim. The wings are of simple venation and somewhat hairy.

The flies appear in spring about the time that the cluster-buds of the Keiffer pear begin to break thru the fruit bud. They may be seen flitting about the lower parts of the trees in the warm sunshine, but on cold days they seek shelter in the cracks of the bark and under the stubble beneath the trees. Mating takes place soon after emergence, but the flies do not frequent the buds until the latter have swollen and egg laying conditions obtain. This is usually correlated with the appearance of the first trace of pink of the petals. The interval of time between the emergence of the flies and oviposition varies considerably from year to year, in some instances a week and in others several weeks. Often temperatures below freezing, snow, and hail occur during this period but seem to have little effect on the apparently delicate midge flies.

When ready to oviposit the female explores the bud surfaces until a favorable site is found. The hair-like ovipositor is then extruded and the attractive bud area sounded further with its sensitive tip. The spot selected for egg laying is usually near the junction of the bases of two sepals. At this point only the edges of one or two folded petals guard the interior of the calyx cup of the future pear blossom. Having found this vulnerable point, the female arches the abdomen and maneuvers the tip of the ovipositor between the folded petals so that it reaches the in-


CLIMATIC RECORD AND SEASONAL HISTORY
OF THE PEAR MIDGE
1928
TEMPERATURE
DEGREES TEMPERATURE
80
70
60
50
40
30
PINK
WHITE
FULL BLOOM
OVIPOSITION
APRIL
FLIES PRESENT
MAY
CLUSTER-BUD
5 10 15 20 25 30 5 10 15 20 25 31
INCHES RAIN FALL
5 10 15 20 25 30 5 10 15 20 25 31
APRIL
MAY

terior of the calyx cup. The actual egg laying takes from ten to fifteen minutes. The flies are not then easily disturbed and one can, by means of a hand lens, plainly see the egg mass discharges go down thru the ovipositor. Usually from 20 to 30 eggs are deposited at a time. They may be found lying in an irregular mass near the base of a stamen of the unopened flower.

The egg is about 0.25 millimeter long and somewhat banana-shaped. It is bluntly rounded at one end and tapers to a long flagellum at the other. Hatching takes place in 4 to 10 days according to climatic conditions. The larvae go directly to the base of the pistil of the flower where they find easy access to the ovary. Because of the uneven development of buds thruout the orchard it usually happens that some buds show white before even the trace of pink is apparent in others. Egg laying continues in the earlier developing buds, the females selecting these in preference to those in a more advanced state. By the time of full bloom the flies disappear very suddenly.

The deposition of eggs in buds of this stage of development appears to be entirely for the protection of the posterity of the midge, since by the time the blossom opens hatching has taken place and the larvae are safely within the ovarial tissue. Young pears so infested develop faster than normal fruits and soon become swollen and deformed. After a few weeks a large proportion of the infested pears drops to the ground, the soft tissue within having been completely destroyed by the midge larvae. While many larvae leave the fruit thru holes and cracks and reach the ground previous to the premature dropping of the infested young fruit, a large number apparently immature at this time, leave the fruit after it has fallen. In a few instances midged pears remain on the tree and reach maturity, but are knotty in shape and not marketable.

Upon reaching the soil, the larvae immediately seek shelter and protection. In a special test 50 larvae placed on loose earth disappeared completely in 3 minutes. Pupation takes place a short time after entering the soil. The puparia are elongate spheroidal in shape, dirty yellow in color, and are encrusted with small particles of sand, dirt, and other debris. The pupal cases are very tough and hard to tear. In this stage the midge remains over winter and the transformation from larvae to adult occurs usually by the first of December.

From life history studies and control experiments of the past few years, it appears that the midge is best combated when in the adult or fly stage. Sprays containing nicotine, such as lime-sulfur and nicotine sulfate; soap and nicotine sulfate; or white oil emulsion, 2 per cent, and nicotine sulfate, ¾ pint in 100 gallons of spray, have given very prom-

ising results. The treatments are put on as the first trace of pink of the petal is seen and the entire tree is well covered so that all flies resting on the trunks and lower limbs are thoroly wetted by the spray. In this way the female flies are killed before very many eggs are laid.

This critical period for spraying is sometimes very short, two or three days at the most, while under adverse weather conditions for tree development it may be a week or longer. The best results so far have been obtained with at least two spray treatments, tho with exact timing one thoro cover should give good protection. It is hoped that this spray may be combined with the early spray for pear psylla and thereby serve two purposes.

THE TOLERANCE OF BEANS TO SPRAYS AND DUSTS FOR THE MEXICAN BEAN BEETLE

By H. C. Huckett, *Riverhead, N. Y.*

Abstract

Results from field tests with commercial brands of arsenicals, barium fluosilicate, and cryolite in spray and dust mixtures for the Mexican bean beetle (*Epilachna corrupta* Muls.) indicate that there is a considerable risk involved in the use of certain forms of arsenical through injury to plant growth. Of the materials tested magnesium arsenate, barium fluosilicate, and cryolite were the safest to use on the foliage at the commonly recommended strengths.

Beans are an important vegetable crop on Long Island, representing an acreage of approximately eighteen hundred acres, most of which is given over to the growing of lima beans. Snap beans are grown as a catch crop for the early summer and fall markets. The varieties are limited to the bush type.

In 1928 the Mexican bean beetle was first recognized on the Island in the vicinity of Selden, about sixty miles from New York. Throughout 1929 and 1930 the pest has evidently been on the increase judged from the number of notices regarding its appearance. To date, the extent of injury caused by the insect has been limited to more or less isolated spots in the fields.

Whilst it is hoped that the insect may be unable to develop into a pest of economic importance locally, it has been thought advisable to make tests of various insecticides on bean foliage with a view to meeting possible emergencies. It is also very evident in reviewing the literature concerning the artificial control of this pest that there is need for tests of a local nature to determine the degree of saftey wherewith new and old insecticides may be used on the bean plant.

The tests were carried out at the Long Island Vegetable Research Farm on a uniform piece of ground, each test consisting of a row of snap beans thirty or sixty feet in length.

The spray mixtures were applied three times by means of a knap-sack sprayer in such quantities as to thoroughly wet the foliage; in the case of arsenicals the applications averaged 200 gallons per acre, and in the case of fluosilicates about 220 gallons per acre.

The dust mixtures were applied when the plant was moist or "dry" and was done by means of cheese cloth bags, and although, as in the case of spraying, twice the amount of material was used as is generally recommended, yet it seemed that many of the leaves were left with insufficient dust for protective purposes. The applications averaged at the rate of 40 pounds per acre.

The materials used were guaranteed as follows on the commercial packages:

Lead arsenate.	
Total arsenic pentoxide (As_2O_5)	30.0%
Arsenic in water soluble form, expressed as metallic arsenic, not more than	.5%
Calcium arsenate.	
Total arsenic pentoxide (As_2O_5)	40.0%
Arsenic in water soluble form, expressed as metallic arsenic, not more than	.5%
Magnesium arsenate.	
Total arsenic pentoxide (As_2O_5)	32.0%
Arsenic in water soluble form, expressed as metallic arsenic, not more than	.23%
Cryolite (a synthetic product).	
Sodium aluminum fluoride	98–99%
Barium fluosilicate.	
Brand "D" Barium fluosilicate	95%
Inert ingredients	5%
Brand "B" Barium fluosilicate	75%
Inert ingredients	25%
Brand "G" Barium fluosilicate	80%
Inert ingredients	20%

The spray formulae were as follows:

Lead arsenate or Calcium arsenate or Magnesium arsenate or Barium fluosilicate — 3 lbs. to — Kayso 3 lbs., Water 100 gals. or Bordeaux mixture (4.6.50) 100 gals.

The dust formulae were as follows:

Lead arsenate or Calcium arsenate or Magnesium arsenate — 1 lb. to — Hydrated lime or Monohydrated copper sulfate 15 / Hydrated lime 85 — 4 lbs.

Cryolite or Barium fluosilicate — 1 lb. to — Hydrated lime or Monohydrated copper sulfate 15 / Hydrated lime 85 — 2 lbs.

The first application was made on August 16, about a month after the plants had appeared above ground, the second, on August 25 and 27 for

dusting and spraying respectively: and the third, on September 8 for spraying, and on September 6 and 11 for dusting the plants when wet and dry respectively.

Seven days after the first application it was apparent that there was considerable injury among plants sprayed or dusted with lead or calcium arsenate mixtures. In these cases it was evident that where the arsenicals had been combined with Bordeaux mixture or copper-lime dust the injury had been noticeably curtailed. On the other hand the rows sprayed or dusted with magnesium arsenate, cryolite or the different brands of barium fluosilicate gave a good appearance, especially when the insecticide had been used with Bordeaux mixture. No doubt part of the credit due to the superior showing of the rows receiving additional fungicidal treatment was owing to the control of the bacterial spot. (*Bacterium vignae* Gard.)

Two pickings of pods were made on September 10 and 24 respectively. On September 30 the plants were weighed, and the results are given in the following tables.

TABLE 1. THE COMPARATIVE WEIGHTS OF PODS AND VINES OF BEANS SPRAYED THREE TIMES WITH INSECTICIDAL MIXTURES

Insecticidal Ingredients	Weight of Pods per 100 Plants Spray Mixture			Weight of Vines per 100 Plants Spray Mixture		
	Kayso-Water lbs.	Bordeaux Mixture lbs.	Average lbs.	Kayso-Water lbs.	Bordeaux Mixture lbs.	Average lbs.
Arsenicals						
Lead arsenate	4.28	4.52	4.40	1.84	2.81	2.32
Calcium arsenate	4.65	4.71	4.68	2.75	2.84	2.79
Magnesium arsenate	7.98	7.27	7.63	4.33	4.67	4.50
Fluosilicates						
Cryolite	7.62	7.33	7.48	5.02	4.73	4.88
Barium fluosilicate (D)	7.54	7.12	7.33	2.90	4.02	3.46
(B)	8.17	8.05	8.11	3.31	3.59	3.45
(G)	8.18	7.19	7.69	3.75	3.59	3.67
None	7.83	6.25	7.04	3.77	4.04	3.90
Untreated checks	7.65	8.18	7.92	3.62	3.87	3.74

REMARKS ON SPRAY MIXTURES. Magnesium arsenate was the only arsenical that could be used with any degree of safety. Lead and calcium arsenates caused a considerable reduction in yield and serious injury to the foliage which resulted in premature defoliation of the plants. When used with Bordeaux mixture there was slightly less injury as a result of treatment but not to such a degree as to offset the advantage gained in using magnesium arsenate.

TABLE 2. THE COMPARATIVE WEIGHTS OF PODS AND VINES OF BEANS DUSTED THREE TIMES WITH INSECTICIDAL MIXTURES

Insecticidal Ingredients	Weight of Pods per 100 Plants Dust Mixtures: Hydrated Lime Plants Wet lbs.	Hydrated Lime Plants Dry lbs.	Copper-Lime lbs.	Average lbs.	Weight of Vines per 100 Plants Dust Mixtures: Hydrated Lime Plants Wet lbs.	Hydrated Lime Plants Dry lbs.	Copper-Lime lbs.	Average lbs.
Arsenicals								
Lead arsenate	2.25	2.03	2.54	2.27	1.92	1.68	1.76	1.79
Calcium arsenate	.58	3.00	2.69	2.09	.80	3.00	2.14	1.98
Magnesium arsenate	3.82	5.19	2.71	3.91	3.45	4.42	2.33	3.40
Fluosilicates								
Cryolite	2.76	4.20	3.51	3.49	2.36	3.07	2.86	2.76
Barium fluosilicate								
(D)	4.02	5.03	4.66	4.57	4.14	4.43	4.33	4.30
(B)	4.25	3.94	4.81	4.33	4.16	3.85	4.21	4.07
(G)	7.12	3.83	7.90	6.28	5.37	3.83	5.40	4.87
None	4.06	6.95	5.00	5.34	3.11	4.62	4.11	3.95
Untreated checks	4.83	4.93	4.40	4.72	4.12	4.42	3.73	4.09

The fluosilicates compared very favorably with magnesium arsenate relative to the degree of safety exhibited. The yield of pods averaged fully as high as that obtained from plants sprayed with magnesium arsenate, but the vines averaged slightly less in weight.

There was a tendency for the yield to be cut slightly when Bordeaux mixture was used, no doubt as a result of blossom injury. On the other hand there was generally a slight increase in weight of vines receiving treatment with Bordeaux mixture.

REMARKS ON DUST MIXTURES. Magnesium arsenate averaged the best results of the arsenicals. In the cases of magnesium and calcium arsenates the results were improved when the dust mixtures were applied to plants with "dry" foliage as compared to plants with foliage moistened with dew. With calcium arsenate this factor did not however offset the advantage to be gained in using magnesium arsenate.

With the fluosilicates there were some marked variations in results, although generally they averaged slightly superior to those from magnesium arsenate. Cryolite was inferior to barium fluosilicate. There was no uniform duplication of the results obtained with arsenicals, namely, that it was safer to dust when the plants were "dry" than when moist: with two brands of barium fluosilicate the results were negative, and with the other together with Cryolite the results were positive.

The results obtained by the use of copper-lime as a diluent were generally as satisfactory as those obtained with hydrated lime under the best of circumstances, with the single exception of magnesium arsenate.

OBSERVATIONS ON THE BEAN LACE-BUG IN PUERTO RICO

By M. D. LEONARD and A. S. MILLS, *Rio Piedras, P. R.*

(Withdrawn for publication in the July 1931 issue of the Journal of the Department of Agriculture of Puerto Rico.)

RECENT OBSERVATIONS ON DISTRIBUTION AND ABUNDANCE OF *ANOMALA ORIENTALIS* WATERHOUSE AND *ASERICA CASTANEA* ARROW IN NEW YORK[1]

By HAROLD C. HALLOCK, *Associate Entomologist, Division of Deciduous-Fruit Insects, United States Department of Agriculture*

ABSTRACT

The records include not only the range of *Anomala orientalis* and *Aserica castanea* but notes on their general abundance during the past four years at localities where they have been found to occur in New York State. The drought, which was the longest dry period that has been recorded in this area, decreased the abundance of these beetles. The use of lead arsenate in top-dressing lawns has helped to reduce the abundance of the beetles.

Since *Anomala orientalis* Waterhouse and *Aserica castanea* Arrow, were definitely identified in 1926 as occurring in New York, our knowledge concerning their distribution and abundance in this state has increased each year. In this second paper (2)[2] on distribution and abundance of these insects I desire to discuss, along with their known range and abundance in New York, a very important limiting factor, the drought, in so far as it appears to have affected their abundance in this area. The extensive use of lead arsenate in top-dressing lawns has also affected their abundance in many localities in the New York area but I will not attempt to give any figures on this limiting factor until more extensive data can be secured.

During the summer of 1929 Long Island, and especially the northern half of Nassau County, suffered from a very severe drought. The precipitation figures given by the United States Weather Bureau (5, 6) show that the rainfall at Roslyn, N. Y., during this 1929 drought period

[1]Contribution No. 87, Japanese Beetle Laboratory, Moorestown, N. J.

[2]Numbers in parenthesis refer to "Literature cited," p. 212.

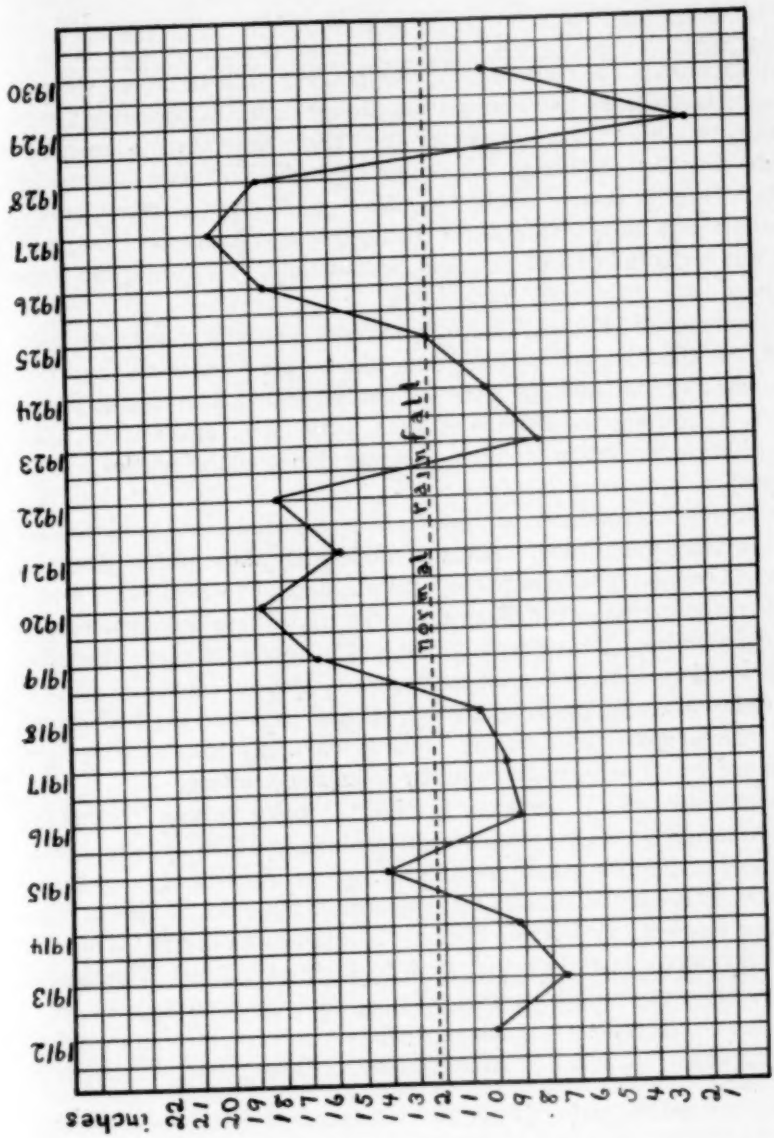


FIG. 7.—Total rainfall during June, July and August at Roslyn, N. Y., for years 1912–1930 inclusive.

was as follows: June 1.14 inches; July, 0.29 inch, and August, 1.14 inches; which made a total of 2.57 inches. (Fig. 7.) When there is less than 1.5 inches of rainfall in a month at any locality in the states along the Atlantic seaboard, the United States Weather Bureau classes it as a drought month. The records from 1826 to 1928 (4, 5, 6) do not show in the Long Island area two consecutive drought months occurring in any one summer, but in the summer of 1929 there were three consecutive drought months. Although the center of the Westchester County infestation (Fig. 8) is only[3] about 15 miles from Roslyn, Nassau County, conditions were more favorable for the beetles in Westchester County as there was a rainfall of 5.64 inches at Scarsdale, N. Y., during the three months of June, July, and August, 1929.

The summer of 1930 was also dry and more generally called a drought period, but this area suffered less than some other parts of the country. There was a rainfall of 10.09 inches at Roslyn and 12.32 inches at Scarsdale, N. Y., during the months of June, July, and August 1930. The effect of these two summers upon the abundance of the beetles will be discussed later under each species.

The degree of abundance of these two beetles will be divided into four classes in this paper, dense, abundant, moderately abundant, and scarce. Dense will be used to designate those infestations where beetles are found in such numbers that either the grubs or the adults have become economically destructive. The term abundant will be applied to cases where the beetles are found in fair numbers but not causing economic injury. Moderately abundant will be applied to cases in which the beetles are found without extensive scouting. Scarce will apply to cases where the beetles are found only occasionally by intensive scouting.

Anomala orientalis Waterhouse is known to occur in New York State in five counties; Bronx, Nassau, Queens, Suffolk, and Westchester. (Fig. 8.) Areas of dense infestation are found in the vicinity of Glen Cove, Jericho, and Roslyn in Nassau County and in the cities of Mount Vernon, New Rochelle, and White Plains in Westchester County. The outlying infestations extend on the north to Bedford Village, Westchester County, and near Smithtown Branch in Suffolk County to the east.

The dense infestations of *Anomala orientalis* in Nassau County reached a peak in 1928. (Table 1.) After the severe three months' drought in

[3]In both this and the following figure the solid black represents dense infestations, the shaded represents abundant infestations, the area where the dots are placed at regular intervals represents moderately abundant. The dots outside these areas represent localities where beetles have been found but they are scarce.

1929 there was a noticeable decrease in the abundance of the beetles on Long Island. In localities where 500 to 600 adult beetles could be collected in two hours on hot days in 1928, it was difficult to secure 100

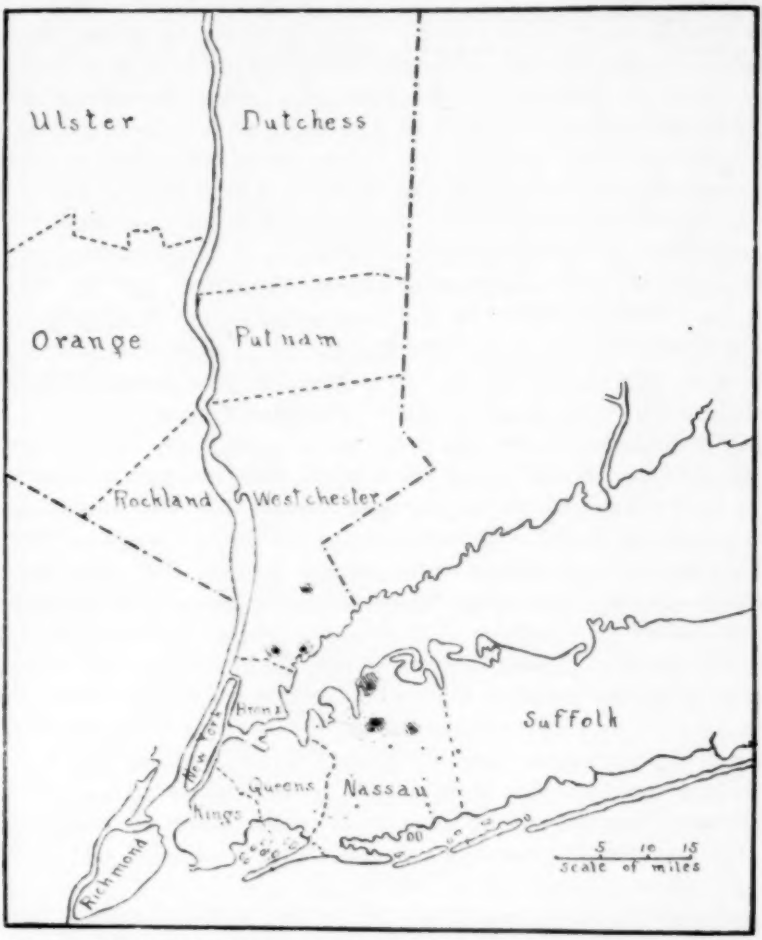


FIG. 8.—Distribution of *Anomala orientalis* Waterhouse in New York in 1930.

beetles in half a day in 1930. Extensive grub surveys have been made at these localities each year since 1927 and these data also show that the insects have become less abundant. (Table 1.) The grub population at the dense infestations near Jericho, N. Y., dropped from an average of 78 grubs per square foot in 1928 to 12 in 1929, but in 1930 the average was

19 grubs per square foot. The lawn turf injured by grubs in 1928 at Jericho was approximately eight acres, while in 1929 turf injury was reduced to approximately 200 square feet at Jericho and this section was normally very moist.

In 1930 injury of a new type by *Anomala orientalis* grubs occurred at Jericho where they were found feeding in a garden on roots of strawberry, corn, bean, and rhubarb. In this cultivated area grubs were observed as numerous as 37 to a square foot and nearly all the plants in a strawberry bed were killed. In this garden the soil is less porous than upon the lawns because considerable organic material has been added to the soil in the form of stable manure containing straw and peat moss. The moisture was also preserved by the formation of a dust mulch through cultivation or a straw mulch on the strawberry bed.

In the vicinity of Roslyn, N. Y., there was some drop in the abundance of the beetles because of the 1929 drought but a larger area of turf was harmed in 1929 than at Jericho. In 1930 nearly three acres of lawn were ruined by the Anomala grubs in the vicinity of Roslyn.

In Westchester County less reduction of grub injury to turf can be credited to the drought as the grubs in the densely infested areas were thick in the lawns which had not been treated with lead arsenate. In this county the Board of Supervisors and the Farm Bureau in 1928 informed the property owners of the damage done by the insect and the methods recommended by the United States Department of Agriculture for its control (3). A large number of the property owners, where injury had occured, followed these recommendations. The control measures were as follows: use on the lawn a top-dressing of one bushel of soil with 5 pounds of lead arsenate for each 1,000 square feet of lawn to be treated. Large areas of lawn in Nassau County have also been treated with lead arsenate since 1926. Lawn protection has been secured in every case where the correct amount of lead arsenate in the top-dressing has been distributed evenly over the lawn, and this has helped to reduce the abundance of the insect in New York.

Although the rainfall was about the same in the beetle area in Nassau County, the abundance of *Anomala orientalis* was reduced less around Roslyn than in the vicinity of Jericho. At the Jericho Anomala infestation there is only four to twelve inches of top-soil covering a very porous gravelly sub-soil. The soil at the infestation around Roslyn, where the insects survived in larger numbers, has a thicker layer of top-soil and as a result the soil dried out less rapidly. Jericho is in the Ronkonkoma moraine region while the infestations around Roslyn are located on the Harbor Hill moraine or the wash out from the Harbor Hill moraine. It

has been pointed out in a United States Department publication that a more porous soil should be expected at Jericho than at Roslyn, since till is more abundant in the Harbor Hill moraine than in the earlier Ronkonkoma moraine (1, p. 169 & soil map). It is apparent that *Anomala*

FIG. 9—Distribution of *Aserica castanea* Arrow in New York in 1930.

orientalis will remain abundant during years when there is a drought summer if the soil is not so porous that all traces of moisture disappear.

Aserica castanea is known to occur in New York State in eight counties; (Fig. 9) Bronx, Dutchess, Nassau, New York, Queens, Suffolk, Ulster, and Westchester. Areas of dense infestation, where plant injury

has been observed, occur on Long Island in Nassau and Queens Counties in the vicinity of Douglaston, Garden City, Glen Cove, Great Neck, Jericho, Little Neck, Manhasset, Old Westbury, Roslyn, Searingtown, and Westbury, and in Westchester County in the vicinity of Mount Vernon, New Rochelle, Scarsdale, White Plains, and Yonkers. Isolated infestations have been found along the south shore of Long Island in Suffolk County near Babylon and Patchogue, while north of the dense infestation in the Metropolitan New York area the beetles may be found moderately abundant in the northern part of Westchester County in the vicinity of Amawalk. Two isolated infestations, where the beetles are scarce, have been observed still further north in New York, one at Fishkill, Dutchess County, and the second at Kingston, Ulster County. The Kingston infestation is about 70 miles north of any known dense infestation.

Although *Aserica castanea* was affected by the drought, the beetles were able to survive in greater numbers than those of *Anomala orientalis*. The Aserica adults feed and fly actively at night and conceal themselves in the ground during the day. When the season is unusually dry large numbers of adults are found concealed in the ground in moist places. Although favored food plants may be present at localities where the ground has become extremely dry, the beetles leave the dry places for localities where they can find moist soil in which to conceal themselves during the day and for oviposition. On the other hand Anomala adults do not fly as actively as those of Aserica and they tend to remain at the one locality even though the ground should become too dry for the eggs and newly hatched larvae to survive.

During 1928 and the spring of 1929 Aserica grubs were widely distributed over a ten-acre lawn north-east of Westbury and turf injury was very noticeable over large areas of this lawn. During the 1929 drought the adults congregated in a low wet area on the east side of this lawn. When the three dry months were past grubs were very scarce in the main portion of the lawn but they averaged approximately 100 to a square foot (maximum 345) in the moist area.

The grubs of Aserica became economically injurous in cultivated areas at East Williston, Glen Cove, Roslyn, and Westbury during 1929–1930 winter and the 1930 summer season. At Roslyn about 150 square feet of young Begonia plants in a cold frame were severely injured and many plants were killed. Young nursery stock in flats in a greenhouse was killed during the winter months at Westbury. Strawberry, beet, onion, and young corn plants were killed in gardens during May and June, 1930, by the feeding of Aserica grubs. These gardens had not been in sod for

a number of years. In the fall of 1930 grubs were again found in cultivated gardens and at that time their number was from 10 to 15 per square foot.

It has been found advisable throughout these studies on abundance to consider adult beetle activities along with the grub abundance data in order that the insect abundance could be estimated more accurately. The total foliage injury observed in 1930 throughout the New York area was approximately one-third the injury noted during 1928. The beetles caught in the electric light traps have decreased as a result of the dry weather. At the same locality one electric light trap caught, during the season, 188,250 beetles in 1928, 107,690 beetles in 1929, and 17,126 beetles in 1930. The largest catch of beetles in a single night by this trap was 21,012 in 1928, 11, 600 in 1929, and 2,362 in 1930. The area where this trap was located, has been reduced by the drought from an area of dense infestation to one of abundant infestation. Observations were made annually during July and August upon the abundance of beetles concealed at the base of their food plants during the day. In 1930 at the dense infestations from 10 to 86 beetles were found at the base of a single food plant. When the beetles were very abundant in 1928 observations at areas of dense infestation showed from 10 to 140 adults at the base of individual plants. All of these facts show that the drought caused a marked reduction in their abundance.

TABLE 1. GRUB POPULATION OF *Anomala orientalis* AND *Aserica castanea* IN NEW YORK STATE

Number of grubs per square foot of turf examined

Locality	1928				1929				1930			
	Anomala orientalis		Aserica castanea		Anomala orientalis		Aserica castanea		Anomala orientalis		Aserica castanea	
	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.
Albertson	—	—	26	11	1	rare	94	22	1	rare	95	22
Jericho	553	78	3	rare	44	12	17	8	64	19	29	13
Mt. Vernon	119	41	80	38	41	25	43	17	65	27	51	22
Roslyn	135	83	90	35	48	18	27	17	108	67	83	27
Queens	—	—	7	2	—	—	27	13	—	—	30	19
Westbury	3	rare	157	42	1	rare	345	41	2	rare	153	53

Although the abundance at the dense infestations has been reduced by the drought, the beetles have been observed in a larger territory in New York than at any earlier period. The 1930 observations show more localities where injury has occurred, although the injury was less extensive at these localities (Fig. 9) than in 1929 or 1928. In 1928 there were only five areas of dense infestation (2) while in 1930 there are sixteen areas of dense infestation which are connected by an area where the beetles are abundant. The beetles have spread outward from the earlier dense

areas and it is now possible to observe a considerable difference in their abundance in the infested territory. An area where the beetles are abundant surrounds and connects these dense infestations. This area is also surrounded by a region varying in width where they are moderately abundant. The isolated infestations do not appear to be connected with the other infestations at the present time. (Fig. 9.)

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RECENT CHANGES IN JAPANESE BEETLE LARVAL POPULATION IN PHILADELPHIA MUNICIPAL PARKS[1]

By HENRY FOX, *Associate Entomologist, Bureau of Entomology, United States Department of Entomology*

ABSTRACT

Changes in Japanese beetle (*Popillia japonica*) population tend to follow a definite sequence characterized by an initial rapid increase leading to a period of maximum abundance and followed by a decline. Illustrated in this paper by the results of an annual survey of the soil population of the insect for four successive years in three of the small municipal parks or "squares" of Philadelphia.

As early as 1926, observations in the field seemed to point to a definite, even if slight, decline in the density of the Japanese beetle population occurring in the region about Riverton and Moorestown where the insect earliest became established and in which it first increased to epidemic proportions. On the other hand, it was noticed at the same time that the insect seemed to be present in all its former strength and abundance in a section of more recently occupied country, forming a zone several miles in width surrounding the original area. These observations

[1]Contribution No. 86, Japanese Beetle Laboratory, Bureau of Entomology, Moorestown, N. J.

naturally suggested the possibility that changes in Japanese beetle population in any given locality might follow a definite course, characterized by an initial rapid increase to the point of maximum strength, followed by a steady decline. Impressed by the importance of getting clear information bearing upon this point, the writer, early in 1927, started a series of periodic surveys designed to yield something approximating a measure of the degree of abundance of the insect from year to year in a number of stations distributed throughout nearly the whole of the territory then known to harbor it. These surveys were based upon the number of larvae of the Japanese beetle found in the ground beneath a measured area of surface. Some of the stations selected for investigation were situated in the region originally occupied by the insect, others in more recently occupied territory where it had about reached its maximum strength, and still others, farther out, in a section where it was only beginning to attain abundance. By distributing the different stations about in this fashion, it was felt that the information obtained would cover all varieties of change through which a Japanese beetle population would be likely to pass in the course of years.

In selecting the various stations for examination, consideration was given primarily to such questions as their suitability for breeding grounds for the beetle and their probable permanence as such and availability for examination. For these reasons, the greater part, by far, of the stations were located in golf courses and municipal parks, experience having shown that these were preferred by the beetles above all other types of habitat as the places in which to deposit their eggs.

With a few special exceptions, these periodic surveys are being conducted once a year, beginning about April 1 and terminating on, or soon after, June 15. Usually a day is devoted to each station. As a rule, numerous diggings, each one foot square, are made, distributed at frequent intervals through the whole of the tract under examination. The larvae of the Japanese beetle, so exposed, are counted and their number recorded for each digging. From the results thus obtained, the average number of larvae per square-foot is computed. This average, with some qualifications depending upon the varying topographic or other conditions prevailing in the different habitats, are regarded as affording a fairly reliable index of the degree of abundance of the larvae in each station.

The results of these surveys are now available for four years in succession, and, with a few local exceptions, serve to confirm the original impression of a decrease in the earlier occupied sections and of a rapid increase in those more recently invaded. Owing, however, to limitations

of space and the difficulty which necessarily inheres in presenting, under such circumstances, a bald statement of results obtained in a variety of stations, differing more or less widely in such details as topography, soil types, plant cover, etc., the writer, in the present paper, has chosen to limit consideration to three stations in which conditions throughout are so nearly alike, in all obvious particulars, that the results yielded may be accepted as quite comparable.

The stations selected are three of the small municipal recreational parks, locally termed "squares", situated in the central metropolitan section of Philadelphia.[2] Each occupies a single block. Its area is consequently quite limited, and this, combined with its level surface and relatively uniform cover of grass, tends to make conditions as favorable for the larvae in one part as in another. For this reason the general averages obtained in the surveys at these points furnish a more satisfactory criterion of the actual state of the general beetle population than they do in most of the other stations where greater environmental diversity obtains.

TABLE 1. RESULTS OF A QUANTITATIVE SURVEY OF THE LARVAL POPULATION OF THE JAPANESE BEETLE, *Popillia japonica* NEWM., DURING FOUR SUCCESSIVE YEARS IN THREE SMALL MUNICIPAL PARKS IN PHILADELPHIA, PA.

Year	Date of Survey	Area Surveyed	Number of Larvae per square foot		
			Average	Maximum	Minimum
Franklin Square					
1927	May 27	12 sq. ft.	6,3	9	3
1928	May 21	30 sq. ft.	12.8	24	4
1929	May 22	30 sq. ft.	9.1	27	2
1930	May 20	125 sq. ft.	2.2	12	0
Washington Square					
1927	May 27	12 sq. ft.	4.2	12	0
1928	May 22	22 sq. ft.	7.0	14	0
1929	May 23	15 sq. ft.	4.4	10	1
1930	May 21	101 sq. ft.	2.6	15	0
Rittenhouse Square					
1927	May 27	12 sq. ft.	2.7	7	0
1928	May 24	22 sq. ft.	3.2	7	0
1929	May 27	20 sq. ft.	14.2	38	4
1930	May 22	83 sq. ft.	3.9	19	0

Of these parks, two, Franklin Square and Washington Square, lie within less than a mile of the Delaware River and, therefore, rather nearer the original Japanese beetle center in New Jersey than does the

[2]The writer wishes to express his obligation to the Board of Commissioners of Fairmount Park for permission to conduct surveys in these parks.

other park, Rittenhouse Square, which is located about one mile directly west of Washington Square. On account of their proximity to the original source of the infestation, both Franklin Square and Washington Square became infested about a year in advance of Rittenhouse Square, the westward advance of the beetle through the intervening business section of the city being delayed to that extent, doubtless owing to the scarcity of suitable breeding grounds.

The general results of the larval surveys in these parks through the years, 1927 to 1930 inclusive, are shown in Table 1.

It is to be regretted that, owing to various practical exigencies over which the writer had no control, the amount of ground examined in each of the three years preceding 1930 was so much less than in that year. This was especially true of the initial year, 1927, when scarcely more than a preliminary survey could be attempted. In the following two years conditions were somewhat improved, but it was not until 1930 that facilities were available for conducting the survey on a sufficiently extensive scale. Despite the limited area examined in the earlier surveys, however, it does not seem likely that the results obtained deviate to any considerable extent from those which would have been obtained if, in every instance, the area examined had been equal to that examined in 1930, since experience has shown that the larvae in these parks, in conformity with the uniform nature of the environment, are distributed throughout in approximately equal numbers.[3]

If, as the facts seem to warrant, the results summarized in Table 1 are taken as an index of the conditions obtaining in each park during the time covered by the record, we find that, in every case, there is first an increase in the intensity of the infestation leading up to a year of maximum infestation, which is followed by a decline. At first, the infestation in Franklin Square and Washington Square was heavier than in Rittenhouse Square, which, as has been emphasized, was farther removed from the original centre of the Japanese beetle infestation in New Jersey. In

[3]To test whether this supposition has any basis in fact, the data from the separate square-foot diggings of 1930 were arranged for each of the three parks in ten groups of 12 diggings each, care being taken to distribute the diggings composing each group at random over the entire area, but at very nearly equal intervals. The 30 groups thus obtained yielded averages which in 22 instances, or 73 per cent, did not depart from the general averages for that year, as listed in Table 1, by more than a single unit, while in no case did any group average deviate from the general average of its park by more than 2.1 units. The close agreement of these various group averages and that of the park itself would, therefore, favor the view that one based on an examination of as low as twelve diggings, as in 1927, would nevertheless afford a fairly reliable index of actual conditions.

agreement with their proximity to the latter center, we find the infestation in the two former parks attaining its maximum in 1928, whereas, in Rittenhouse Square, this condition was not reached until a year later, at which time the infestation in the Franklin and Washington Squares had started to decline. It is interesting to note that in 1930 this decline had resulted in a reversal of the conditions found at the start, Franklin Square having the lowest, Rittenhouse Square the heaviest, infestation of the three—a state of affairs which was coincident with the shifting of the general area of heaviest infestation from its original position east of the Delaware to one some miles west of that river.

As regards the degree of infestation reached in the different parks, it will be observed (Table 1) that at no time did it become as heavy in Washington Square as it did in either of the other two. The reason for this difference is apparently to be found in a difference of soil texture. In both Franklin Square and Rittenhouse Square the soil is a light mellow loam, whereas in Washington Square, it is distinctly tougher, having a decidedly clay-like consistency. It is our experience that the adult beetles show a strong tendency to seek out areas of light, mellow soils in which to deposit their eggs and to avoid those into which, on account of their toughness, it is difficult for them to burrow. The failure of the infestation in Washington Square to quite reach the proportions attained in either of the other two parks may, therefore, be attributed to its relatively less attractive soil.

According to Table 1, the heaviest infestation represented at any time was that at Rittenhouse Square in 1929, when an average of about 14 larvae to the square foot was indicated. In this particular instance, however, we have grounds for suspecting this average to be rather too high for the park as a whole. In that year, it was found that an unusually heavy concentration of Japanese beetle larvae was present in one corner of the park, where some resodding had been done in the spring of the preceding year. Owing to the interest aroused by the discovery of this unusually heavy infestation and to the need for tracing its limits, a somewhat greater number of examinations was made in this portion of the park than was made in other sections of equal extent. This, along with the small number of diggings made in 1929, would obviously tend to yield an average too high for the park as a whole. As a result of a restudy of the original data, we are disposed to think that, for that year, a more nearly representative average would be about 12.5 larvae to the square foot, which is very nearly identical with the maximum reached at Franklin Square in 1928.

SUMMARY. Within the last several years, clear indications have been found that, following an invasion, changes in Japanese beetle population in any given locality tend to take a definite course, characterized by an initial rapid increase leading to a year of maximum abundance and followed by a decline.

Local surveys of larval abundance, planned to trace these changes through successive years, have been instituted at numerous points distributed throughout much of the region known to be continuously infested by the species.

In these surveys, the average number of beetles beneath one square-foot of sod is utilized as an index of the relative abundance of larvae in each station.

Owing to the relative simplicity and uniformity of conditions represented, attention is limited, in this paper, to the changes in larval population during four successive years in three of the small municipal parks, or "squares", in the central metropolitan section of Philadelphia.

The results of the surveys in these parks agree with the general view that, following the initial invasion, the changes in larval population follow the course previously outlined. These results are summarized in a table.

PRESENT STATE OF JAPANESE BEETLE DISTRIBUTION IN AMERICA

By HENRY FOX, *Moorestown, N. J.*

(Not received in time for publication.)

DISTRIBUTION OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWN.) IN THE UNITED STATES IN 1930

By C. H. HADLEY and C. W. STOCKWELL, *Plant Quarantine and Control Administration, Camden, N. J.*

Surveys to determine Japanese beetle infestation were made by field scouts of the Plant Quarantine and Control Administration of the United States Department of Agriculture during the summer of 1930 within the area designated as lightly infested in the Eighth Revision of the rules and regulations supplemental to Notice of Quarantine No. 48 (Seventh Revision) and in contiguous territory in the States of Massachusetts, Rhode Island, New York, Pennsylvania, West Virginia, Virginia, Maryland and Delaware. Distant scouting was also performed in the States of New Hampshire, Ohio, North and South Carolina, and Georgia. The

entire scouting program, comprising the work carried on both within and outside the regulated areas, included activities in a total of sixteen States.

The extent of each of the previously discovered infestations was determined at Boston, Mass., Providence, R. I., and Cape Charles, Portsmouth and Norfolk, Va., points outside the Federally regulated area but under State quarantine restrictions; and at Springfield, Mass., New London, Willimantic, Hartford and Meriden, Conn., Kingston and Binghamton, N. Y., Athens, Sayre, Lewistown and Chambersburg, Pa., Delmar, Del., Delmar, Cambridge, Oxford, Chestertown, Federalsburg, Brunswick and Hagerstown, Md., Washington, D. C., and Lyon Village, Alexandria and Ballston, Va., points within the lightly infested regulated areas. Scouting and trapping activities at Athens, Pa., Federalsburg, Md., and Ballston, Va., failed to disclose any infestations resulting from the few beetles collected in these localities during 1929.

Additional scout and trap finds which by the number of beetles collected indicated definitely established infestations were determined at Plymouth, Mass., Newport, R. I., Pittsburgh, Pa., and Parksley and Newport News, Va., points outside the regulated areas; and at West Springfield, Mass., and Branford and Danbury, Conn., points within the lightly infested regulated areas.

Slight infestations of only a few beetles each, indicating incipient infestations, were discovered at Westerly, R. I., Laughlintown, Lock Haven and New Castle, Pa., Attleboro and New Bedford, Mass., Georgetown and Lewes, Dela., and Onley, Melfa and Keller on the eastern shore of Virginia, all points outside the regulated areas; and at Enfield, Conn., South Waverly, Boiling Springs, Carlisle and Lewisburg, Pa., and Weverton, Md., points within the lightly infested areas.

Finds of a single beetle each were made at Waverly and Buffalo, N. Y., Altoona, Tipton, Tyrone and Ligonier, Pa., and Exmore, Va., localities outside the area regulated under the quarantine restrictions; and at Groton and Terryville, Conn., and Frederick, Hyattsville and Oxford, Md., communities located within the lightly infested regulated areas.

The infestation most remote from the site of the original infestation at Riverton, N. J., is that at New Castle, Pa., an air-line distance of approximately 285 miles from the locality in which the beetle was first discovered in 1916. The isolated infestations at Boston, Mass., Buffalo, N. Y., and Pittsburgh, Pa., are all at considerable distances from the area of general infestation.

TRAPPING FOR THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWMAN) DURING THE SEASONS 1929 AND 1930

By O. K. COURTNEY, *Plant Quarantine and Control Administration, U. S. Department of Agriculture, Camden, N. J.*

ABSTRACT

The so-called "Japanese beetle trap" using a bait having geraniol as a base was used during the seasons 1929 and 1930.

Approximately 17,563 traps were used in 1929, and 25,583 in 1930, at an average cost for material and operation of $1.66 per trap in 1929, and $1.63 in 1930. This does not include cost of assembled trap.

During the summers of 1929 and 1930 traps were placed at a number of points where Japanese beetles had been found in small numbers during the summers of 1928 and 1929 as well as in localities where beetles were found for the first time by scouts during the summers of 1929 and 1930. Traps were placed at these outlying points in an effort to reduce the normal increase of beetles and determine the degree of infestation. Besides placing traps in such localities traps were also placed at a few additional outlying points to aid in the scouting to determine possible presence of beetles.

The trap used in this work (Pl. 6) was devised by the Bureau of Entomology and is very simple, consisting essentially of a pail, glass jar, funnel and bait container or basket. Crossed plates attached by welding to the top edge of the funnel act as baffles, against which beetles flying over the open pail strike and fall into the funnel, and then down into the jar. The glass jar at the bottom of the trap makes it very easy for the trap tender to determine whether or not any beetles are in the trap. Experience has shown that this type of trap gives excellent protection to the bait, especially in rainy weather. The trap is suspended on an iron rod, the rod being approximately seven feet long, one-half inch in diameter, with the upper end (7 inches) bent at a right angle, from the end of which the trap is hung on a hook attached through a hole drilled in the end of the rod. The rod when placed in the field is pushed into the ground to a depth of from twelve to eighteen inches, so that the top of the trap is even with, or slightly above, the surrounding shrubbery or plants.

In actual practice, where traps are placed on lawns not close to any shrubbery, they should be placed so as to be at a height of from three to four feet above the ground level. Ordinarily traps are placed in the field at their proper locations before being baited.

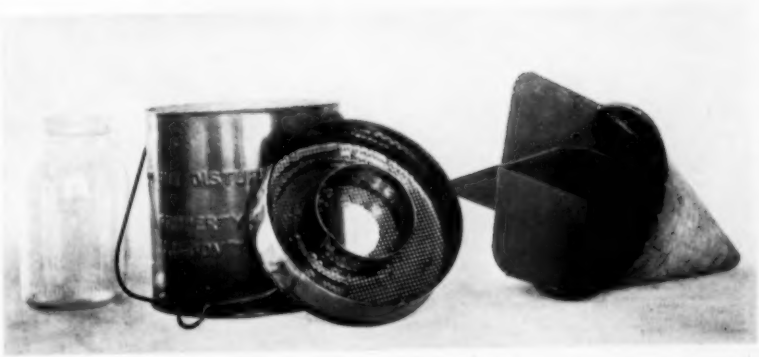
The bait used in these traps was developed from investigations conducted by the Bureau of Entomology. That used for the season of 1930 was prepared according to the following formula:

Geraniol	8 qts.
Eugenol	28 oz.
Bran	83 lbs.
Water	7 qts.
Molasses	21 qts.
Glycerine	7 pts.

In mixing the bait the liquids were measured out and poured into a 20 gallon metal tank equipped with a high speed motor-driven propeller shaft. The end of this shaft was equipped with a set of propellers of push and pull type. This machine, running at 1,750 r.p.m., emulsified the liquids sufficiently to prevent their separating out before being poured over the bran in a large motor driven plaster mixer (Pl. 7). Enough bait was mixed by this method to bait 500 traps one time. The weight of a single batch of bait mixed by the above method was approximately 172 pounds. The bait was kept in tight containers made of tin to avoid loss of strength of the attractive odors.

In laying out the work for the season of 1929 with the traps, it was estimated that one man working eight hours a day could properly take care of 250 traps; this allowed visiting each trap at least twice a week and spending about five minutes in the vicinity of each trap in removing beetles from the trap, hand scouting in the immediate vicinity for any beetles that might not have gone into the trap, and making proper records. Experience has shown that this is a fair estimate of the time involved in handling the traps. The trap tender was required to make daily reports, on forms provided for the purpose, of each trap visited during the day, and keep a record not only of the number of beetles found, but also the weather conditions, and other items of interest. Usually each trap tender sent his reports in daily to the Headquarters Office. In larger cities where three or more men were handling traps, one man was selected as foreman and in addition to looking after his own trap route, supervised in a general way the activities of the other members of the crew, and forwarded the various reports.

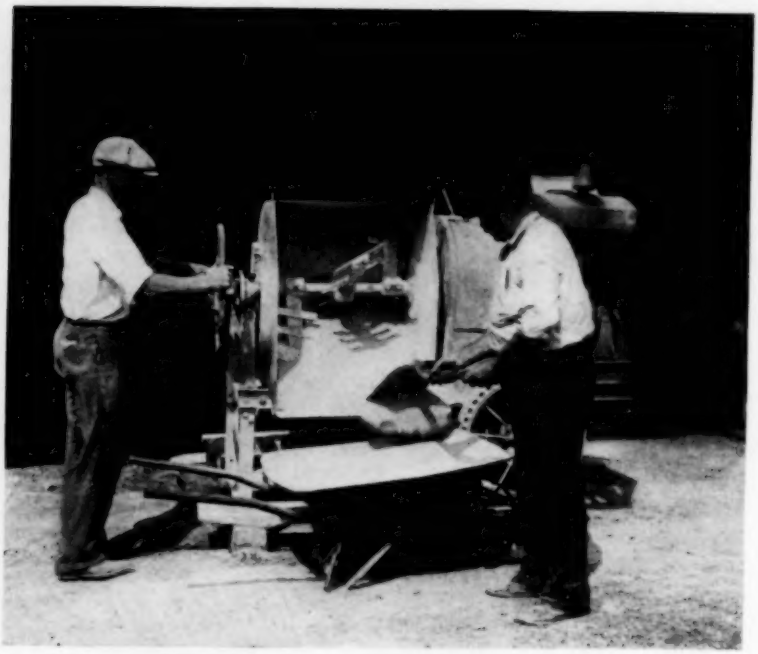
Climatic conditions over the entire area trapped were such as to make it possible to start the work in the southern part of the area, training the men and gradually working them northward, so that it was possible always to start a new trap route with men who had had at least some previous training in the handling of traps. Insofar as it was possible to do so, men were selected as trap tenders who had a college or at least



Japanese beetle trap assembled and unassembled showing the component parts.

UNIV. OF MICH.

Plate 7



Plaster mixer used to mix the bait.

high school training. Experience has shown that such men are more likely to have the necessary initiative and ability to take care of a trap route even when not under close supervision. Each trap tender was required in addition to taking care of his traps, to draw a map of his area showing streets, property lines, house numbers and locations of traps on each property. All beetles collected were properly recorded and sent to the Headquarters Office at Camden for final determination as to species and sex.

Table 1 gives the collections in localities where traps were placed for the seasons 1929 and 1930 while Table 2 gives the collections in localities where traps were placed during the season 1930 only.

TABLE 1. COLLECTIONS IN LOCALITIES WHERE TRAPS WERE PLACED FOR THE SEASONS OF 1929 AND 1930

City	Year	Number of Traps	No. of Points Infested	Date Trap Work Started	Finished	Number Beetles Caught Traps	Scouts	Season's Beetle Total
Connecticut				June 13				
Hartford.....	1929	750	5	Aug. 6–16*	Sept. 13	871	19	890
	1930	1365	6	July 2	Sept. 6	3095	88	3183
New London..	1929	250	1	June 12	Sept. 13	168	0	168
	1930	500	1	July 1	Sept. 4	220	0	220
Willimantic†...	1929	250	1	Aug. 6	Sept. 7	12	9	21
	1930	250	1	July 1	Sept. 3	17	0	17
Delaware								
Delmar.....	1929	250	3	June 5	Sept. 7	980	1	981
	1930	500	1	June 24	Aug. 12	691	0	691
District of Columbia								
Washington...	1929	2500	13	May 19	Aug. 31	3157	23	3180
	1930	5000	6	June 9	Aug. 22	4820	0	4820
Maryland								
Aberdeen†....	1929	250	1	July 31	Aug. 29	13	3	16
	1930	200	1	June 26	Aug. 14	131	189	320
Bel Air†.....	1929	150	1	Aug. 9	Aug. 28	2	13	15
	1930	100	1	June 27	Aug. 14	118	0	118
Brunswick†...	1929	250	1	Aug. 23	Sept. 24	5	6	11
	1930	250	1	June 26	Aug. 14	757	149	906
Cambridge....	1929	1000	3	June 3	Aug. 31	911	2	913
	1930	2000	1	June 20	Aug. 15	2087	0	2087
Chestertown...	1929	250	2	July 22	Aug. 31	4	3	7
†	1930	250	1	June 23	Aug. 15	38	0	38
Delmar.....	1929	250	3	June 5	Sept. 5	608	44	652
	1930	500	2	June 24	Aug. 12	495	0	495
Federalsburg..	1929	129	1	Aug. 5	Aug. 27	0	1	1
†	1930	250	0	June 20	Aug. 30	0	0	0
Frederick.....	1929	250	1	May 27	Aug. 22	0	0	0
	1930	250	1	June 26	Aug. 15	1	0	1
Hagerstown...	1929	250	3	May 28	Sept. 5	47	0	47
	1930	750	6	June 24	Aug. 16	379	165	544
Oxford†.....	1929	250	1	July 23	Aug. 30	0	2	2
	1930	250	1	June 19	Aug. 14	16	1	17

*250 traps placed on each date.
†Traps were set after scouts found beetles in the summer 1929.

TABLE 1. *Continued*

City	Year	Number of Traps	No. of Points Infested	Date Trap Work Started	Date Trap Work Finished	Number Beetles Caught Traps	Number Beetles Caught Scouts	Season's Beetle Total
Massachusetts								
Boston	1929	1150	3	June 22	Sept. 20	179	1	180
	1930	1150	4	July 7	Sept. 6	150	0	150
Springfield	1929	1200	9	June 14	Sept. 13	1037	28	1065
	1930	1650	11	July 3	Sept. 12	1340	13	1353
New York								
Buffalo	1929	250	0	Aug. 10	Sept. 11	0	0	0
	1930	250	1	July 7	Aug. 30	1	0	1
Pennsylvania								
Lewistown	1929	250	1	May 31	Aug. 30	1	0	1
	1930	250	1	June 30	Aug. 22	8	1	9
Pittsburgh	1929	250	0	July 24	Aug. 30	0	0	0
	1930	500	1	July 1	Aug. 21	32	0	32
Sayre	1929	250	1	June 15	Sept. 14	232	20	252
	1930	632	1	June 30	Aug. 30	43	0	43
Rhode Island								
Providence†	1929	250	2	Aug. 3	Sept. 14	162	19	181
	1930	1000	3	July 7	Sept. 6	854	1	855
Virginia								
Alexandria	1929	1000	3	May 24	Aug. 31	3937	3	3940
	1930	2000	2	June 5	Aug. 19	8856	0	8856
Ballston†	1929	125	1	Aug. 10	Aug. 31	0	1	1
	1930	113	0	June 28	Aug. 18	0	0	0
Cape Charles†	1929	200	1	July 27	Aug. 31	25	43	68
	1930	500	1	May 20	Aug. 30	4316	0	4316
Lyon Village†	1929	125	1	Aug. 10	Aug. 31	1	5	6
	1930	118	1	June 28	Aug. 16	104	0	104
Norfolk†	1929	500	3	July 6	Aug. 28	7	5	12
	1930	600	3	May 15	Aug. 15	126	0	126
Portsmouth†	1929	250	1	July 11	Aug. 28	1	1	2
	1930	445	4	June 27	Aug. 15	44	46	90

†Traps were set after scouts found beetles in the summer 1929.

TABLE 2. COLLECTIONS IN LOCALITIES WHERE TRAPS WERE PLACED DURING THE SEASON 1930 ONLY

City	Year	Number of Traps	No. of Points Infested	Date Trap Work Started	Date Trap Work Finished	Number Beetles Caught Traps	Number Beetles Caught Scouts	Season's Beetle Total
Connecticut								
Danbury†	1930	168	4	Aug. 16	Sept. 6	28	3	31
Enfield*	1930	48	1	Aug. 21	Sept. 1	1	2	3
Groton*	1930	35	1	Aug. 30	Sept. 12	0	1	1
Meriden	1929	NOT TRAPPED (3 P. J. unofficially reported)						
	1930	250	1	July 1	Sept. 5	2	0	2
Delaware								
Georgetown*	1930	100	1	July 14	Aug. 12	4	7	11
Lewes*	1930	120	1	Aug. 16	Aug. 26	0	2	2

*Traps were set after beetles were found by scouts during the summer of 1930.

TABLE 2. *Continued*

City	Year	Number of Traps	No. of Points Infested	Date Trap Work Started	Date Trap Work Finished	Number Beetles Caught Traps	Number Beetles Caught Scouts	Season's Beetle Total
Massachusetts								
New Bedford*	1930	163	1	Aug. 16	Sept. 15	2	1	3
Plymouth*	1930	163	1	Aug. 16	Sept. 13	59	32	91
W. Springfield	1930	336	2	July 5	Sept. 4	31	0	31
New York								
Beacon	1929	NOT TRAPPED					58	58
	1930	250	1	July 10	Aug. 30	257	2	259
Binghamton	1929		1	NOT TRAPPED			10	10
	1930	252	1	July 9	Aug. 30	18	25	43
Kingston	1929		1	NOT TRAPPED			13	13
	1930	250	1	July 8	Aug. 29	51	0	51
Newburgh	1929	NOT TRAPPED					37	37
	1930	250	2	July 1	Sept. 2	907	52	959
Waverly	1930	200	1	July 12	Aug. 22	1	0	1
Pennsylvania								
Athens	1929	NOT TRAPPED	1				2	2
	1930	252	0	July 9	Aug. 10	0	0	0
Chambersburg	1929		1	NOT TRAPPED			2	2
	1930	250	1	June 25	Aug. 21	23	0	23
Laughlintown	1930	4	1	Aug. 15	Sept. 15	6	0	6
Ligonier*	1930	8	1	Aug. 15	Sept. 15	0	1	1
New Castle*	1930	100	1	Aug. 14	Aug. 29	0	6	6
S. Waverly	1930	52	1	July 12	Aug. 23	3	0	3
Rhode Island								
Newport*	1930	128	1	Aug. 19	Sept. 11	71	4	75
Westerly*	1930	35	1	Aug. 28	Sept. 11	4	2	6
Virginia								
Keller*	1930	25	1	July 15	Aug. 15	3	12	15
Melfa*	1930	25	1	July 16	Aug. 14	4	4	8
Newport News*	1930	180	2	June 23	Aug. 15	158	51	209
Onley*	1930	25	1	July 16	Aug. 14	0	11	11
Parksley*	1930	75	1	July 16	Aug. 14	9	33	42

*Traps were set after beetles were found by scouts during the summer of 1930.

The heaviest point of infestation in an area can be shown very readily on the map by indicating the traps that caught beetles during the season and the number taken by each trap. Fig. 10 shows the situation at New London, Conn., during the season of 1929.

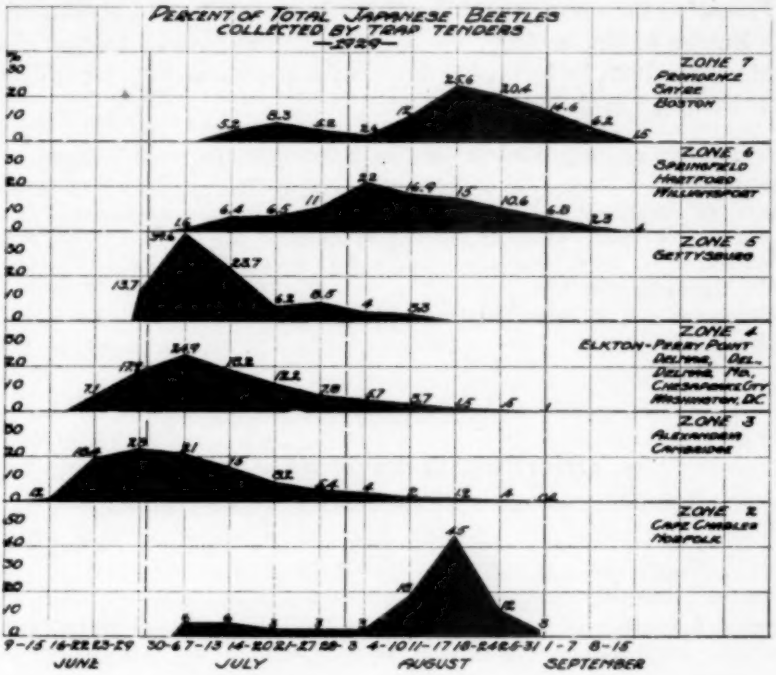
The accompanying chart (Fig. 11) shows the percentage of Japanese beetles collected each week by the trap tenders throughout the season for the cities listed. It will be noted that the largest collections for the season of 1930 were a few days later than for 1929, on the average.

The seasonal cost of operation of a trap will vary not only according to the original cost of the trap, but also depending upon the length of

FIG. 10.—Map of area trapped for the Japanese beetle in New London, Conn., 1929.

the season and other factors. The average cost of operation for both seasons, 1929 and 1930, is as follows:

	1929	*1930*
Cost of trap assembled	$0.82955	$0.7574
Bait material—avg. cost per trap, baited 3 times in 1929 and twice in 1930	$0.14749	$0.1726
Operating cost—avg. per trap (includes bait)	$1.66	$1.63



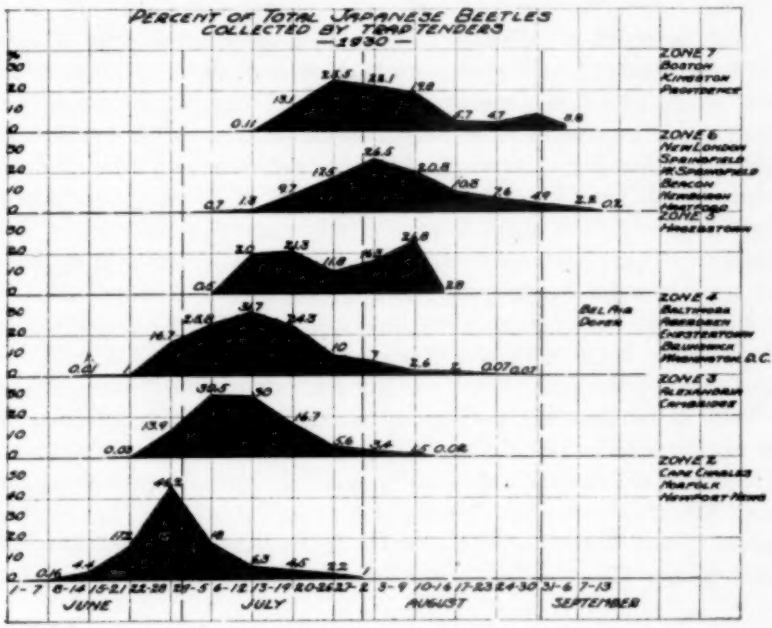


FIG. 11.—Shows the percentage of Japanese beetles collected each week by the trap tenders throughout the season for the cities listed.

Following the recommendation of the Japanese Beetle Laboratory of the Bureau of Entomology, the bait for 1930 was made stronger than that used in 1929, by increasing the geraniol and eugenol content 4 times over that used in the previous season.

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Friday Morning, November 21, 1930

THE FRUIT FLIES OF NEW YORK

By F. L. GAMBRELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

The economic species of fruit flies in New York includes: The cherry fruit flies, *Rhagoletis fausta* and *R. cingulata;* the apple maggot, *R. pomonella;* the walnut husk maggot, *R. suavis;* and the currant fruit fly, *Epochra canadensis.* Certain points relative to the distribution, abundance, life history, and control of these species are discussed.

In the group of fruit flies (Trypetidae) there are records of thirty-seven species and four varieties which are known to occur in the state of New York. Of this number there can be listed, at most, only five species which prove to be of economic importance to the horticultural industry. However this paper only calls attention to certain interesting points which have been obtained in a study of the economic species. Four of these belong to the *Genus Rhagoletis* and the other to the *Genus Epochra.* These are: the cherry fruit flies, *R. cingulata* and *R. fausta;* the apple maggot, *R. pomonella*, and a physiological species of the latter which attacks blueberries; the walnut husk maggot, *R. suavis;* and the currant fruit fly, *Epochra canadensis.*

In view of the fact that New York is one of the important horticultural states it is only proper to call attention to the fact that certain species of fruit flies occupy an important role in this particular industry. Without question the cherry fruit flies and the apple maggot are the two most important economic species under consideration. The cherry industry of the state is represented by approximately 1,500,000 trees of bearing age. The yield in 1930 as based upon the pack of canned and

frozen fruit amounted to 21,185 tons; and figuring this production at the rate of five cents per pound, which is about the average price paid by canners, the value of the cherry crop on this basis was $2,117,500. This figure does not take into consideration that part of the crop which was sold as fresh fruit upon the local markets. The cherry fruit flies are an important problem thruout the state wherever cherries are grown on a commercial scale, and where control measures are not properly and effectively applied this pest often materially affects the quality and value of the crop. Conversely, those growers who adhere to a regular spray program such as that recommended by the Spray Service seldom encounter serious difficulty in producing fruit of a quality which complies with the standards formulated by the federal authorities and maintained by the canning industry, as has been repeatedly shown both from the commercial and experimental standpoint.

The production of apples, which is another important fruit crop of the state, according to information published by the U. S. Census Bureau in 1925, showed a yield of 19,055,965 bushels in 1924. While the apple maggot is neither considered a major pest in all of the apple growing areas of the state nor is it, generally speaking, the most important insect enemy of the crop, serious injury does occur in certain localities and, consequently, it assumes an economic role in those areas. It is of interest to note that the presence of apple maggot in fruit grown in the eastern United States has been sufficient within the past few years to attract attention upon certain foreign markets, with the result that definite action has been taken to minimize the possibility of introduction and establishment of this insect in those countries. Needless to say, the State of New York is not immune from the standpoint of maggot-free fruit. According to Dr. P. J. Chapman, a member of the Entomology Division of the New York State Agricultural Experiment Station, who is conducting an exhaustive study of this insect in the Champlain and Hudson River sections, experimental work has shown that the flies are susceptible to applications of arsenicals to much the same degree as has been pointed out by Glasgow and Gambrell, among others, in the case of the cherry fruit flies (2). Experimental work seems to indicate that properly timed and thoroly applied treatments of arsenicals will afford good control against these insects. In conjunction with the spray program maintained against these and other pests there is introduced, however, the problem of spray residues which is another important consideration.

The walnut husk maggot, *R. suavis*, while not as important as the preceding species under New York conditions, is also worthy of mention.

While the production of nuts is not on such an extensive scale as are cherries and apples, the marketing of the native black walnut is decidedly on the decrease, which is perhaps due in some measure to deforestation practices. In an effort to counteract this situation the black walnut has been supplanted by the English (Persian) walnut to some extent, of which there are an increasing number of plantings in the state. These plantings are more or less limited to the northwestern tier of counties and west of the Cayuga Lake basin, particularly in the region of the Ontario plains and the Niagara peninsula. The walnut husk maggot occurs thruout this region and attacks both wild and cultivated walnuts. In some instances as much as eighty to ninety per cent of the nuts are infested.

Distribution and Abundance. Generally speaking, the presence of these species is associated with the appearance of the various fruits and nuts, but they present important problems only in certain rather restricted areas. In Figure 12 are shown the various physiographic areas of New York and these conform in a general way to the areas of greatest abundance, distribution, and importance of the various species. It also illustrates the principal horticultural areas.

While the apple maggot is rather generally distributed in New York and occurs to some extent in the Central Lakes and Great Lakes regions, it is much more abundant and causes considerably greater losses in the Champlain area and Hudson River valley than in any other sections of the state. Likewise, the cherry fruit flies occur in all the cherry growing areas, but in contrast to the apple maggot are of about equal importance in the Great Lakes, Central Lakes, and the Hudson Valley regions and appear to develop equally as well in each locality. As has been previously noted, the walnut husk maggot has been observed principally thruout central and western New York, but is also known to occur in the Hudson valley. According to records thus far the currant fruit fly has been found in the northeastern part of the state along the Champlain valley, and may possibly occur in some other sections. The blueberry maggot, which is a physiological strain or species of the apple maggot, occurs on Long Island, but thus far the writer has observed this species neither in the Adirondack mountains region nor in western New York.

Comparison of Life Habits and Control. A detailed discussion of the life history and control of any one of these species requires more discussion than space permits here. The cherry fruit fly studies, carried on under the direction of Dr. Hugh Glasgow and assisted by the writer, and the apple maggot problem which is being extensively investigated by

Dr. P. J. Chapman in the Champlain and Hudson valleys, will be the subjects of publications by the New York State Agricultural Experiment Station in the near future and need not be elaborated upon at this time. However, there are three points to which the writer desires to call attention. *First:* The apple maggot, even tho it occasionally feeds upon blueberries and plums, is in the main monophagous in its feeding habits; the cherry fruit flies thus far have only been reared from the cultivated

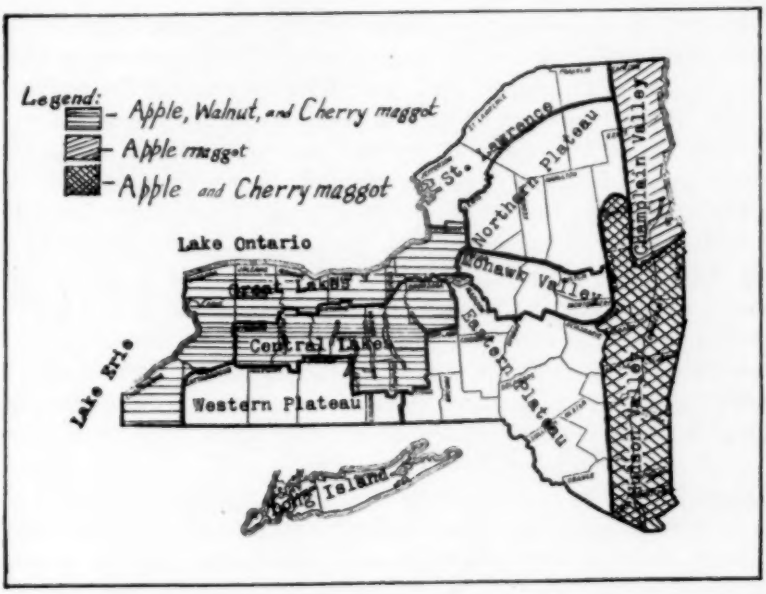

FIG. 12.—Physiographic areas, horticultural regions and distribution of fruit flies of economic importance in New York.

cherry and are apparently monophagous species; the walnut husk maggot, while probably not entirely a monophagous species, has only been reared from four species of nuts, all of which belong to the *Genus Juglans*. *Second:* All of these species are, in the main, single brooded. *Third:* All of these species are susceptible to arsenicals and do not appear to be attracted to bait traps. These points are all in striking contrast to such species as the Mediterranean fruit fly, the Mexican orange maggot, and others which are polyphagous in feeding habits, multi-brooded, and are attracted to bait traps.

WALNUT HUSK MAGGOT. The writer for the past few years has been interested in that phase of the fruit fly study which deals with the wal-

nut husk-maggot (*R. suavis*), its life history and control, phylogenetic relationship, susceptibility to arsenicals, and similarity of habits to the other species of the group. *R. suavis completa*, a subspecies of *R. suavis* and *R. juglandis*, have recently been observed in the nut growing area of California and threaten to become important insect pest. of English walnuts there (3, 4, 5). The discussion relative to this species (*suavis*) is included here to summarize the information as obtained under New York conditions.

The walnut husk-maggot attacks butternuts, black, English, and Japanese walnuts on which the larvae feed within the exocarp or hull of the nut. The eggs are deposited during August beneath the surface of the hull, and number from a very few to one hundred or more in a single puncture. There is usually but one puncture to a nut, but occasionally two are observed. Injury by the walnut husk maggot manifests itself in three different ways: first, in impairing the quality of the kernel within the shell; second, in causing the husk or exocarp to stick to the shell; and third, in a blackening of the shells which makes them unattractive. Some of the nuts which become infested early in the season fall prematurely, while others remain on the trees long after normal nuts have fallen from the husks to the ground. In some instances where nuts are attacked when still premature the shell becomes soft and the entire kernel may be destroyed by the maggots or rendered worthless by the attack of fungi.

Injury is first detected by the presence of an egg puncture as a small, black, circular spot from which exudes a sap that adheres to the surface of the nut and upon drying appears as greyish-brown to black, irregular, discolored areas (Plate 8). In feeding the larvae tunnel their way thru the exocarp and as they approach maturity work their way towards the outer surface of the husk, at which time the nuts show several small, brown to black, water-soaked spots, or a few well defined, large discolored areas. The larvae issue from the husks from about September first to November first, and pupate within the soil at depths of from one-half to one and one-half inches, in which condition they remain until the following summer. The flies usually begin to emerge about July 15 and continue until the middle of August. The life history of this and the other species, as based upon the emergence of flies, is shown in Figure 13.

While the degree of control of the walnut husk maggot has not been as striking in some respects as that obtained against the cherry maggots, this study reveals the fact that the flies are susceptible to applications of arsenicals. The efforts relative to control have been somewhat limited owing to the small number of trees available for experimental work, but

Injury of the walnut husk maggot (*Rhagoletis suavis*) on butternut. Upper left: egg puncture and fluid which has exuded from the husk; remaining nuts show different stages of injury.

the control obtained under such conditions compares favorably with that secured against the cherry maggots under similar circumstances. Two applications of dry-mix or lime-sulfur and arsenate of lead, the first one made from ten days to two weeks after the initial emergence of

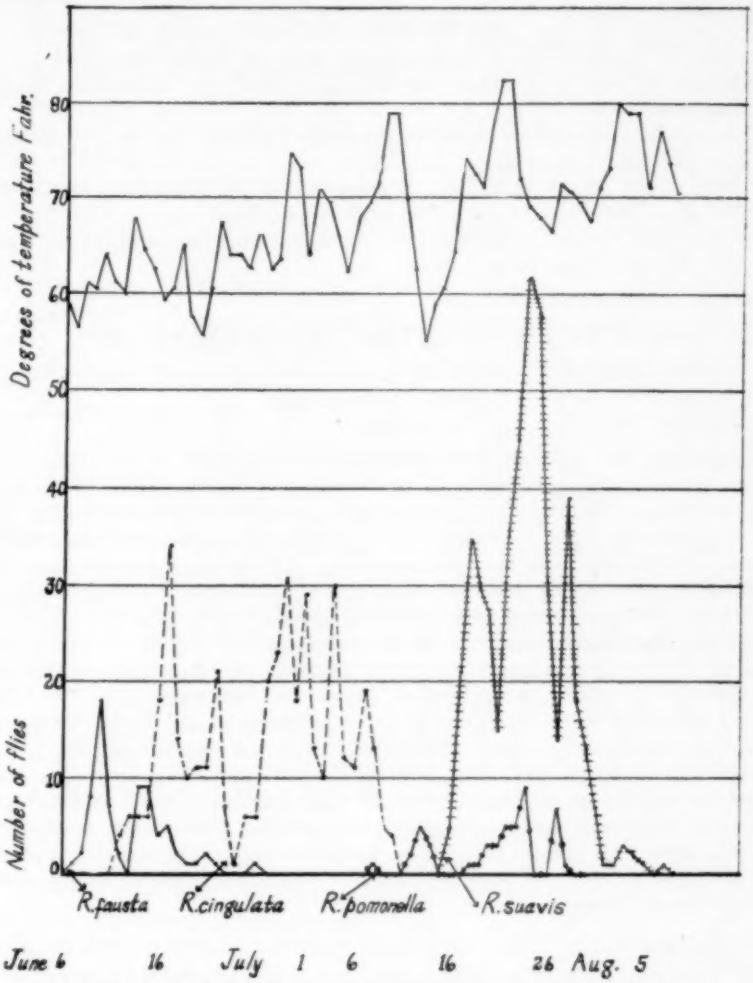

FIG. 13.—Showing daily temperature and emergence of fruit flies.

flies, and the second from one week to ten days later, have given upwards of ninety per cent control. As in the case of cherry fruit flies, in small plantings or individual trees which are in close proximity to untreated trees, there is a migration of flies between such trees which exerts a

marked influence upon the control obtained. Generally speaking, the flies are susceptible to treatments of arsenicals, and in the case of commercial plantings or trees which are some distance from untreated trees little difficulty should be encountered in securing satisfactory control.

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INSECTICIDE INVESTIGATIONS DURING 1930

By E. P. FELT and S. W. BROMLEY, *Bartlett Tree Research Laboratories, Stamford, Connecticut*

ABSTRACT

Molasses nicotine soap sprays, which have proven effective in the control of certain delicate insects, were applied with safety to a series of thirteen species of trees at a molasses dilution of 1–20. Tulip and gray birch showed slight injury at this dilution. Due to the dry seasons of the past two years, the chinch bug, *Blissus leucopterus* Say became a serious lawn pest in certain localities. A series of sprays and dusts were tested for its control, with potassium oleate plus nicotine appearing the most promising. A series of sprays were tested for the control of the rhododendron lace bug, *Stephanitis rhododendri* How., with results indicating the value of the spray when there was a thorough wetting of the insect. Dormant oil sprays were demonstrated as effectively controlling oak leaf rollers, *Argyrotoxa semipurpurana* Kf., by killing the overwintering eggs. The tulip tree scale, *Toumeyella liriodendri* Gmel., was effectively controlled by certain dormant oil sprays, but only partial controls were obtained after foliation had taken place and the scale had advanced in growth and resistance. Field tests with dormant oils on sugar maples and black walnut demonstrated the injurious effects of such sprays on these trees. Spray injury tests with oil and lime sulfur on foliage of various trees revealed a certain type of injury characteristic of this combination, while combinations of soap and arsenate of lead on conifers also produced a characteristic type of injury.

Every year brings innovations in the control of insects. New problems arise with the advent of new insect pests, while control measures for some of the old established pests are not in all cases the most satisfactory which it is possible to devise. Experimentation is continually bringing forth new methods, and the ever increasing number of new insecticides being made available to the public brings a challenge to the entomologist, which must be met by the most careful research methods.

Spraying shade trees and ornamentals presents many more problems, sometimes acute ones, than ordinarily develop in commercial fruit orchards. The variety of trees and shrubs is greater and many are characterized by marked limitations in tolerance to sprays. In addition, the necessity of taking into consideration plants and shrubs upon which the spray may drift, as well as those which are to be treated, must be faced.

Investigations of insecticides in reference to their effects both on the insect pest and the plant have occupied an important part in the activities of the Bartlett Tree Research Laboratories, and the following summarized tests represent some of the outstanding developments in this work during the past season.

I. MOLASSES-NICOTINE-SOAP SPRAYS. It is highly desirable that a spray possess, in addition to its initial killing effect, a more lasting action, either lethal or repellent. This is obtained in the case of a stomach poison, such as arsenate of lead, which serves as a protection to the foliage until eliminated by the elements. With contact sprays, the result of the spray is in most cases simply temporary. The use of molasses in contact sprays has been a step in the direction of lengthening the time over which such a spray would be effective.

The use of a combination of molasses, nicotine and soap as a spray for the control of the box leaf midge is well known. This spray was first recommended in the form of simply the molasses and water by Cory in 1918, and has since, with different modifications, been widely used. Hamilton (1925) recommended a dilution of molasses, one part to four of water, plus nicotine sulfate (1–500). The action of the molasses is mechanical, entangling the delicate midges.

It would seem that this principle could be effectively employed also, in the control of other delicate insects, where the molasses could be used at a strength sufficient to cause the entrapping of the insect, without producing foliage injury.

Satisfactory controls have been obtained with a molasses, nicotine, soap combination on the following:

	Molasses dilution
The hackberry leaf gall psyllid (*Pachypsylla mamma* Riley)	1–44
The hackberry bud gall psyllid (*Pachypsylla gemma* Riley)	1–10
The maple Nepticula (*Nepticula sericopeza* Zeller)	1–80
The oak red spider (*Paratetranychus bicolor* Banks)	1–20

A number of different kinds of trees were sprayed with molasses, nicotine, soap sprays to determine the effect of this combination on the

foliage. A small amount of leaf injury resulted on tulip and sugar maple in 1929, the amount of burning being proportional to the amount of molasses used in the spray. Injury resulted on these two species of trees and also poplar, when molasses was used at a proportion of one part to ten of spray.

A series of different trees was sprayed in 1930 with the molasses, nicotine, soap combination, varying the proportion of molasses, 1–20; 1–40 and 1–80. Tulip and gray birch showed slight marginal burning with the 1–20 dilution, but were uninjured by the weaker strengths. The following showed no injury with any of the three strengths tested:

Hickory	Hackberry
Catalpa	Red Cedar
Sugar Maple	Sweet Cherry
Poplar (tremuloides)	Sour Cherry
Pin Oak	Flowering dogwood
White Oak	Hawthorn
White Pine	

For most insects controllable by this type of spray, the weaker dilutions of molasses would probably not be effective, although what might be considered as an indication at least, was obtained in the case of the maple Nepticula, where a dilution of 1–80 was used.

At the proper dilution, this spray combination appears very promising for the control of many small delicate insects, such as midges, psyllids, aphids and thrips.

II. Lawn Sprays for the Control of the Chinch Bug (*Blissus leucopterus* Say). The dry seasons of the past two years were exceptionally favorable to an outbreak of this insect on lawns. It appeared in great numbers in certain parts of Westchester County, N. Y. and southwestern Connecticut, and caused a great deal of damage on a number of estates before the cause of the dying patches of grass was ascertained by the owners.

A series of tests were conducted with several types of sprays and dusts for the control of the chinch bug in these situations. The results are shown in the following table.

One of the main difficulties encountered was the fact that many of the bugs were in the soil at the base of grass stems, and were thus protected from the sprays to a certain degree. The only materials used which were seen to kill the bugs in numbers almost immediately were the Cyanogas and the Potassium oleate-nicotine.

Date	Material	Rate per 10,000 sq. ft.	Applicator	Time of application	% Kill	Effect on Grass
July 11	Pyrethrum soap 1–80 (Pyrethrol)	100 gals.	Pwr. sprayer	3:00 p.m.	55%	No injury
July 11	Nicotine sulfate 1–800 (Black Leaf 40) Soap Powder—8 lbs. (Kirkman's)—100 gals.	100 "	Pwr. sprayer	3:30 p.m.	15%	No injury
July 14	Summer Oil 2% (Light Volck) Nicotine sulfate 1–800 (Black Leaf 40)	400 "	Bucket pump	2–3:30 p.m	45%	No injury Grass glossier green
July 14	Summer Oil 2% (Light Volck) Nicotine sulfate 1–800 (Black Leaf 40)	400 "	Sprinkler can	2–3:30 p.m.	55%	No injury Grass glossier green
July 14	Carbon disulphide emulsion (1–50) (Thomas)	400 "	Bucket pump	2–3:30 p.m	23%	Slight browning
July 14	Carbon disulphide emulsion (1–50) (Thomas)	400 "	Sprinkler can	2–3:30 p.m.	24%	Slight browning
July 14	Red Arrow (1–1200) Red A Soap 1–128	400 "	Bucket pump	2–3:30 p.m.	27%	No injury
July 14	Red Arrow (1–1200) Red A Soap 1–128	400 "	Sprinkler can	2–3:30 p.m.	32%	No injury
July 14	Red Arrow (1–600) Red A Soap (1–128)	400 "	Bucket pump	2–3:30 p.m.	33%	No injury
July 14	Red Arrow (1–600) Red A soap (1–128)	400 "	Sprinkler can	2–3:30 p.m.	50%	No injury
July 14	Calcium cyanide (Cyanogas "A" Dust)	15 lbs.	Niagara Hand Duster	2–3:30 p.m.	100 %	Severe burning
July 19	Calcium cyanide (Cyanogas "A" Dust) Washed down half hour later	10 "	Niagara Hand Duster	2:00 p.m.	52%	Very slight burning
July 19	Calcium cyanide (Cyanogas "A" Dust) Washed down immediately	10 "	Niagara Hand Duster	2:20 p.m.	13%	Practically no burning
July 24	Pyrethrum soap 1–80	100 gals.	Pwr. sprayer	8:00 p.m.	13%	No injury
July 24	Summer Oil 2% (Light Volck) Nicotine sulfate 1–1000 (Black Leaf 50)	100 "	Pwr. sprayer	8:30 p.m.	*62%	Grass glossier green
July 28	Potassium oleate (0.5%) (Crystal) Nicotine sulfate 1–800 (Black Leaf 40)	92 "	Bucket pump	11:30 a.m.	84%	No injury
July 28	Summer Oil 2% (Light Volck) Nicotine sulfate 1–800 (Black Leaf 40)	350 "	Bucket pump	11:45 a.m.	36%	No injury

*The bugs appeared to be moving out of this area, hence the figure is probably too high.

III. Contact Sprays for the Control of the Rhododendron Lace Bug (*Stephanitis rhododendri* How.). Difficulty is sometimes en-

countered in obtaining a satisfactory control of this insect by the ordinary nicotine soap sprays. While it is probable that the difficulty of obtaining a thorough application is one of the major factors, it was decided to test a number of contact insecticides for the control of this lace bug. The applications were made on July 25th, when most of the insects were in the adult stage.

A. Sodium oleate (So-Fyne) 1–50 plus nicotine sulfate (Black Leaf 40) 1–800, killed the adults almost immediately and gave a very satisfactory degree of control, the few living probably being due to practical spray limitations. The next day the kill was estimated at 91%.

B. Potassium oleate (Crystal) (0.5%) plus nicotine sulfate (Black Leaf 40) 1–800, possessed excellent wetting properties, sticking the insects down to the foliage almost immediately. A count ten minutes later on representative branches showed 192 dead and 2 alive. The next day, the kill was placed at 97%.

C. A summer oil (Light Volck) 2% plus nicotine sulfate (Black Leaf 40) 1–800, did not possess the wetting properties of the two preceding. Many of the insects were hit, but the globules of spray rolled off quickly. The insects moved about after being hit, and the next day very little kill was in evidence.

D. Pyrethrum soap (Pyrethrol) 1–80 gave a good wetting, both to the plant and to the insects, but did not kill immediately. Forty-five or 50 of the insects appeared to be affected ten minutes after the application. The next day, the kill was estimated at practically 100%.

IV. Dormant Oils. Where an insect can be controlled equally well by a dormant spray as by a summer spray, there is a tendency to use the former in preference to the latter. Any damage that the insect might cause is thus forestalled and in addition, there is an advantage in doing the work at a less busy season.

Oak Leaf Rollers. Dormant oils have been successfully used in controlling leaf rollers in orchards for some years, by killing the overwintering eggs. There has been a severe outbreak of leaf rollers attacking oaks in the Stamford area for several years, the most prevalent species being *Argyrotoxa semipurpurana* Kf., as identified by Dr. Busck. A red oak, four pin oaks and two scarlet oaks were sprayed with Sunoco 1–16 on January 7 and 8 in 1930. These trees were in a woodland known to be badly infested. Egg masses were noted on the trees in question. The results were very striking. By the end of May, most of the neighboring unsprayed oaks were practically defoliated, while the treated trees were in full vigorous foliage. A pin oak sprayed April 14th with Dendrol 3% showed similar protection.

TULIP TREE SCALE (*Toumeyella liriodendri* Gmel.) For several seasons, the tulip tree scale has been on the increase in southwestern Conneticut, reaching its peak of abundance in 1929. During the summer of 1930, the parasites and predators were sufficiently abundant to almost completely control the scale on many trees. Great numbers of young scale overwintered, however, and were abundant on trees in North Stamford in the early spring of 1930. Dormant oils give very satisfactory control and have been used extensively. A comparative test of several brands and combinations was made in 1930 and the results are given in the accompanying table. The estimate of the kill was made by counting the number of live and the number of dead scale on representative branches, pruned off the trees, except in the case of the 10 foot tree, where the entire tree was examined. The number of scale varied from 850 to several thousand per branch.

TABLE—TULIP TREE SCALE

Size of Tree, Approx. Height	Spray	Date	Kill of Scale	Number Branches Counted
75 ft.	Sunoco (1–16)	Jan. 7, 1930	100%	3
45 ft.	Sunoco (1–16)	Jan. 8, 1930	100%	3
45 ft.	Sunoco (1–16)	Jan. 8, 1930	100%	3
60 ft.	Sunoco (1–16)	Mar. 26, 1930	100%	5
80 ft.	Ortho-Kleenup (1–25)	Mar. 31, 1930	86.7%	8
10 ft.	Dendrol 3%	Apr. 5, 1930	100%	–
45 ft.	Sunoco (1–50) plus B. L. 40 (1–800)	Apr. 5, 1930	55.7%	2
60 ft.	Sunoco (1–50) plus Penetrol (1–200)	Apr. 5, 1930	44.4%	3
45 ft.	Black Leaf 40 (1–1600) plus Penetrol (1–200)	May 10, 1930	7.9%	4
53 ft.	Light Volck (2%) plus Black Leaf 40 (1–800)	May 14, 1930	20.8%	4

No oil injury resulted on any of these trees.

INJURIES RESULTING FROM OIL SPRAYS. There has always been some questions as to just what dormant oil sprays were safe and what were not on various trees and shrubs. The senior author has long been of the opinion that the danger from dormant oil sprays was considerably greater when the application was made weeks or even months before the starting of growth in the spring. In other words, fall and mid-winter applications are more likely to result in injury than those just before the buds break. It has long been known that the sugar maple is particularly susceptible to injury from oils. However, it was thought that a comparative test with several types of oils might be desirable. Accordingly, a number of sugar maples were sprayed and the results are here presented in tabular form.

Size of Tree Approx. Height	Spray	Date 1930	Time of Application	Temperature	Rel. Humidity	Effect
7 ft.	Sunoco (1–16)	Jan. 6	2:55–3:30 p.m.	45°F.	65%	May 23. 50% of branches dead
7 ft.	Sunoco (1–16)	Jan. 6	2:55–3:30 p.m.	45°F.	65%	May 23 50% of branches dead
6 ft.	Dendrol 3%	Jan. 6	2:55–3:30 p.m.	45°F.	65%	May 23 Slightly delayed, otherwise no apparent injury
5 ft.	Dendrol 3%	Jan. 6	2:55–3:30 p.m.	45°F.	65%	May 23 Top dead.
30 ft.	Sunoco (1–16)	Jan. 7	2:30–3:50 p.m.	54–51°F.	82%–94%	May 23 Several lower branches dead
30 ft.	Sunoco (1–16)	Jan. 7	2:30–3:50 p.m.	54–51°F.	82%–94%	May 23 Several lower branches and several higher up, dead
30 ft.	Sunoco (1–16)	Jan. 7	2:30–3:50 p.m.	54–51°F.	82%–94%	May 23 Parts of 10 lower branches killed
30 ft.	Sunoco (1–16)	Mar. 26	2:25 p.m.	42°F.	48%	May 23 Lower ¾ of tree killed July 18 Tree entirely dead
18 ft.	Ortho-Kleen-up (1–25)	Mar. 31	10:50 a.m.	44°F.	44%	May 23 Foliage thinner and paler than that of adjacent trees
50 ft.	Volck 2% Bordeaux (14 lbs.–100) Nicotine sulfate (1–800) (B. L. 40)	Apr. 25	11:15 a.m.	50°F.	44%	May 23. Leaves small and pale. Growth considerably retarded. July 18. Normal

Red oak, pin oak, blue beech, tulip and yellow birch sprayed with Sunoco 1–16 January 7, 1930 under the same conditions were uninjured. A shagbark hickory similarly sprayed had two-thirds of its branches killed. Another sprayed March 26 with Sunoco 1–16 under the same conditions as indicated in the table for that date, was uninjured.

Four black walnuts (18–20 ft.) sprayed on March 26 with Sunoco 1–16 were severely retarded, the tips of one-third to two-thirds of the branches being killed.

The obvious conclusion from these records is that it is not safe to apply miscible oils to sugar maples or black walnuts, although some commercial brands are less likely to cause injury than others. Even under the best conditions, the application appears close to the danger line, though no material injury was caused.

SUNOCO OIL AND LIME SULFUR[1]. We were interested to ascertain the possibilities of injury resulting from spraying with Sunoco 1–50 followed by lime sulfur 1–40 and the application of these sprays in combination. They were applied May 20th to apple, white oak and sugar maple foliage, only small twigs being used and a hand atomizer employed, May 30th apple foliage sprayed with Sunoco 1–50 appeared somewhat dry, the undersides and margins showing a reddish tinge. That treated with Sunoco at the above strength followed by lime sulfur 1–40 showed a bright rusty red spotting, the spots coalescing in some cases and the leaves entirely reddish brown in severe cases. The branch sprayed with Sunoco 1–100 showed conditions similar to that sprayed with this miscible oil at 1–50 as recorded above. The branch sprayed with Sunoco 1–100 followed by lime sulfur 1–40 had 10% of the foliage spotted, though the injury was not so severe as in the case of the treatment where Sunoco 1–50 was used. The spraying with lime sulfur 1–40 of this series resulted in practically no injury. Spraying with Sunoco 1–50 and lime sulfur 1–40 in combination resulted in 75% of the leaf surface being spotted, as in the previous tests with this combination. The branch sprayed with Sunoco 1–100 and lime sulfur 1–40 in combination had 20% of the leaf surface spotted in this manner.

The injury to white oak foliage from these sprays was slight and evidenced by a dark browning at the base of the leaves and where the leaf tissue was not completely killed, the burning was evidenced by a pale green or yellowish color. Sunoco 1–50 produced practically no injury. Sunoco 1–50 followed by lime sulfur 1–40 resulted in practically all the leaves being injured at the base. Sunoco 1–100 resulted in very light yellowing at the base of the leaves. Sunoco 1–100 followed by lime sulfur 1–40 resulted in similar though less marked injury than in the case where Sunoco was applied at 1–50. Lime sulfur 1–40 produced no injury. Sunoco 1–50 and Sunoco 1–100 each with lime sulfur at 1–40 produced yellowing bases of leaves estimated at 8% of the leaf surface in the case of Sunoco 1–50 and at 5% in the case of Sunoco 1–100, both, as stated, in combination with lime sulfur at 1–40.

The sugar maple results were as follows. Sunoco 1–50 caused a burning of 30% of the leaf surface. Sunoco 1–50 followed in ten minutes by lime sulfur 1–40 browned all the leaves, affecting 80% of the entire leaf surface. Sunoco 1–100 caused a very light yellowing, only about 5% of the surface being affected. Sunoco 1–100 followed by lime sulfur 1–40 burned

[1]This series of tests was run to determine the type of injury which would follow on certain trees from this combination of sprays. Sunoco oil is, of course, not ordinarily used as a foliage spray and its use as such is not recommended by the manufacturers.

approximately 60% of the leaf surface. Lime sulfur 1-40 injured 50% of the leaves. Sunoco 1–50 in combination with lime sulfur 1–40 and Sunoco 1–100 in combination with lime sulfur 1–40 resulted in 80% and 50% respectively of the leaf surface being killed.

Soap and Arsenate of Lead. The effect of applying a soap spray, especially a nicotine soap combination, to foliage previously sprayed with arsenate of lead has come under observation during the last few seasons and some experimental tests were a part of our program the past season. June 11th, red pine, Scotch pine, Norway spruce and hemlock were sprayed with Grasselli's Arsenate of Lead paste, 12 pounds to 100 gallons. On the following day one large Norway spruce was sprayed in the same way. June 24th, 13 days later, these trees were sprayed with Black Leaf 40 1–800 and Ivory Soap flakes, 7 pounds to 100. Very little rain had fallen in the intervening period. Six days after the nicotine soap application had been made, two-thirds to three-fourths of the length of the needles on the sprayed area of the Scotch and white pines were browned and dead. The red pine had from one-sixth to one-fourth of the length of the needles in that condition and some two weeks later a number of the needles were completely browned. The injury to hemlock was evidenced by damage to the tips in the case of some needles and in others it included almost all of the needles and this was followed by dropping of the foliage some two or three weeks after the spraying. The Norway spruce showed injury only to occasional needles and to tips of needles.

EXPERIMENTS IN SPRAY RESIDUE REMOVAL

By L. R. Streeter, P. J. Chapman and G. W. Pearce,[1] *New York State Agricultural Experiment Station*

Abstract

Preliminary tests are given on commercial methods of removing apple spray residues in New York. Acid-insoluble spray residues (especially sulfur), road dust and spotting from the leafhopper (*Typhlocyba pomaria*) are also considered.

On account of the restrictions with respect to spray residues and insect infestation placed by the British authorities on apples exported from the United States, special attention was given this past summer to efforts involving the control of the apple maggot and the removal of obnoxious spray deposits. Generally speaking, apple growers were desirous

[1]The writers are indebted to the John Bean Mfg. Co., for use of machines and helpful suggestions.

of securing satisfactory control of this pest and a larger proportion than usual made the needed number of applications besides spraying the trees more thoroughly than has been customary in recent years.

So far as the Hudson Valley and the Lake Champlain areas were concerned, the summer months were hot with precipitation below normal. The spray operations of the growers, coupled with seasonal conditions, brought to the front the question of spray residues and the possible need for their removal.

Recalling the recent experiences of the orchard industry of the Pacific Coast States, it might be assumed that there was little of interest or value left to be said on this subject. However, as this paper attempts to point out, it is evident in this respect that the practices of one region are not a true criterion of proper procedures for another area. We give here a preliminary report of the nature of spray and other foreign deposits on apple fruits in New York State together with methods of their removal. The object of this study was to gain information on the local situation in the event that spray residue removal might become a necessary practice at some future time.

It was hoped that the methods employed for the removal of spray deposits on the Pacific Coast would be feasible with slight modifications for New York conditions. To our surprise, the initial efforts with the washing of apples, using a late model jet spray type of machine, established clearly that we were confronted with problems somewhat unlike those for which this type of machine was originally designed. In our case the stumbling block was the excessive accumulation of sulfur residues, especially those from lime-sulfur. Apple scab, generally speaking, is a serious disease in New York orchards and to combat it satisfactorily lime-sulfur is customarily used throughout the spraying season. Dry mix (sulfur, lime and calcium caseinate) or sulfur dusts are frequently used in place of lime-sulfur for the late summer applications. Soon after application the lime-sulfur spray decomposes into insoluble materials including elemental sulfur and calcium sulfate. These relatively insoluble sulfur residues are not satisfactorily removed by washing.

The removal of acid-insoluble residues may assume a peculiar importance in New York State. In addition to the sulfur residues may be included road dust, cement dust, and leafhopper excrement. Apples are not infrequently coated with one of the above-mentioned residues to such an extent as to lower their market value. For example, one grower left six hundred barrels of apples on the trees because they were so heavily coated with road dust as to make them unfit for market. Residues

of this type are not uncommon, as indicated by Shear[2] who called attention to them several years ago in the Hudson Valley. The second brood of the leafhopper *Typhlocyba pomaria* was unusually abundant in certain Hudson Valley orchards in 1930. The deposits of excrement by these insects was especially apparent on the Greening apple. In fact so excessive was this spotting in some instances that such fruit was discriminated against by the buyer.

Analyses during the last three years have shown that arsenical residues in excess of the world tolerance may occur where late summer sprays have been used. In years of normal rainfall however, experience indicates that much fruit may fall well below the tolerance with the present spray practices. However, from the standpoint of appearance alone arsenical sprays, non-arsenical sprays, road dust, and leafhopper excrement are all more or less equally objectionable. For these reasons methods designed to improve appearance, independent of arsenic removal, may assume a peculiar value.

For experimental tests on spray residue removal five varieties of apples were obtained from typical well sprayed orchards. For most of our experiments a modern jet spray type of washing machine was used. Our attention was immediately called to the persistence of large quantities of residue on the apples sprayed with lime-sulfur and arsenate of lead after the washing, rinsing and drying treatment. The acid concentration of the washing solution was gradually increased from .165 per cent of hydrochloric acid to 2.5 per cent without a satisfactory improvement in the appearance of the fruit.

Chemical analyses show that the arsenic was satisfactorily reduced in the washing process. Three-tenths of one per cent of hydrochloric acid by weight or one per cent by volume of 20° Be′ acid was sufficient to remove the arsenical residue, and one-half of one per cent by volume appears to be adequate for light residues. While the washed apples were well below the world tolerance in regard to arsenic, their appearance was but slightly improved, a factor to be considered with the increasing demand for clean attractive fruit. Attempts to remove road dust and leaf hopper excrement by washing alone were unsatisfactory.

Somewhat disappointed with the results of the washing process, we next experimented with dry cleaners. The insoluble sulfur residues and road dust were removed quite satisfactorily with a cloth wiper, but this method failed to remove the leafhopper excrement. Our analyses show

[2]Shear, E. V. Bulletin No. 575 New York State Agricultural Experiment Station, October 1929.

that dry cleaners cannot be depended upon to remove other than light arsenical residues. This cleaning method polishes the fruit. It is not very efficient in removing deposits from the stem and calyx ends as pointed out by workers on the Pacific Coast.

In order to remove the arsenical residues and also the insoluble residues, we next combined the washing and wiping processes. Washing removed practically all of the arsenic and the dry cleaning removed the insoluble residues. Apples coated with road dust were also cleaned by the combined treatments. We have as yet been unable to find a method to satisfactorily remove the leafhopper spotting.

The following table gives some typical results of chemical analysis for arsenic on apples after the washing and wiping treatments.

CLEANING EFFECT OF WET AND DRY METHODS

Grains of As_2O_3 per pound of Apples

Method	McIntosh[1]	McIntosh[2]	N. Spy[2]	R. I. Greening	Snow[2]	Ben Davis[3]
Check	.022	.018	.018	.012	.018	.016
Acid Wash .165%	—	.003	.003	.002	—	—
Acid Wash .3%	.005	.002	.002	.002	.003	.006
Acid Wash 1.0%	—	.001	.002	.001	.001	—
Rotating Cloth Wiper	.015	—	.010	.007	.006	.006
.3% acid wash and cloth wiper	.005	—	.002	.001	.002	—

[1]Summer sprays consisted of arsenate of lead 3 pounds, lime-sulfur 1 gallon, dusting sulfur 8 pounds, hydrated lime 4 pounds, calcium caseinate ½ pound, water to make 100 gallons. Final spraying July 30. Picked Oct. 2. This fruit was held in common storage one month before treatments.

[2]Received sprays of arsenate of lead 3 pounds, lime-sulfur 2½ gallons, water to make 100 gallons. Final treatment August 7. Picked Oct. 4.

[3]Summer sprays of arsenate of lead 3 pounds, dusting sulfur 16 pounds, hydrated lime 8 pounds, calcium caseinate 1 pound, water to make 100 gallons. Final treatment Aug. 10. Picked Oct. 30.

Drying the fruit by blasts of air was the principle employed in the washing machine used in most of these tests. In another machine on the market the excess moisture on the fruit is removed by dragging absorbent towelling or "string mops" over the fruits as it advances on the conveyor. Through the courtesy of Dr. W. S. Hough of the Virginia Agricultural Experiment Station at Winchester and the American Fruit Growers at Inwood, West Virginia, the writers were able to use samples of our test fruit in such a machine. From this small test the following observations were made: The moist cloths in the drying unit removed a considerable amount of the sulfur residues and also were fairly successful against road dust. This machine lacked the polishing action found in the rotating dry wiper so that from this particular test at least little of

the natual bloom was removed. More insoluble residue persisted on fruit run through this machine than on the experimental lots which passed through the combined dry wiper and washer.

These experiences indicate that the standard washing machines using hydrochloric acid as a solvent are entirely satisfactory for removing arsenical residues, but that methods meeting the needs of the Pacific Northwest are not entirely adaptable to the needs of the Northeast. It would seem that for the several types of residues encountered in our studies a machine is needed combining the washing and wiping principle. No single machine now on the market entirely meets these requirements.

SOME FACTORS AFFECTING THE EFFICIENCY OF CONTACT INSECTICIDES. I. SURFACE FORCES AS RELATED TO WETTING AND TRACHEAL PENETRATION

By FRANK WILCOXON and ALBERT HARTZELL, *Yonkers, N. Y.*

(Withdrawn for publication elsewhere.)

PREPARATIONS CONTAINING ROTENONE FOR USE AS INSECTICIDES. I. AQUEOUS SUSPENSIONS

By HOWARD A. JONES, *Insecticide Division, Bureau of Chemistry and Soils,* and WILLIAM M. DAVIDSON, *Insecticide Control, Food and Drug Administration, U. S. Department of Agriculture, Washington, D. C.*

ABSTRACT

Aqueous suspensions of rotenone were prepared by two general methods, namely: the addition of rotenone solutions in water miscible solvents to water and the mixing of powdered preparations of rotenone with water. Numerous solvents and protective colloids were tested. Permanent suspensions containing 0.05 to 0.5 gram of rotenone per liter and having the rotenone in a highly dispersed condition were obtained by the addition of pyridine solutions and acetone solutions containing tannic acid to water. Mixtures of certain dry protective materials with precipitated rotenone also gave satisfactory suspensions, when first made into a paste with water and then diluted to the desired concentration.

Permanent suspensions of rotenone were more readily obtainable in slightly alkaline conditions. It was found difficult to obtain lasting suspensions in hard water.

Reference is made to entomological tests previously made with these suspensions.

Numerous investigations have been made, particularly during the past few years, concerning the chemical and physical properties of rotenone, a material found in East Indian plants of the genus *Derris* and in the South American genus *Lonchocarpus*. Tests of the insecticidal action of pure rotenone, the active insecticidal principle of Derris, are of

recent date and, although much work remains to be done along this line, the results thus far obtained indicate that rotenone will become one of our most valuable insecticides.

The possible methods of preparation of this substance for use as an insecticide in spraying and dusting are numerous. For spraying purposes the rotenone has been incorporated in emulsions or used in aqueous suspensions, while for dusting the dry powdered rotenone has been mixed with a suitable carrier. In the making of insecticides containing rotenone certain properties of the material must be considered. Thus it has been common practice to recommend the preparation of a mixture of Derris extract, soap and water for spraying purposes (2, 6, 8, 9). However, it is now known that rotenone is sensitive to the action of alkalies. Hence the use of alkali soaps, or other materials which give an alkaline reaction in solution, as emulsifying agents or as protective colloids in the preparation of aqueous suspensions, must be avoided. A mixture of dry powdered Derris root and hydrated lime has been suggested as a dusting material (11), but this is undesirable for the same reason. The use of clays, calcium carbonate, or other neutral carriers for this purpose would seem advisable (3, 10, 17).

Pure rotenone is almost insoluble in water and only slightly soluble in petroleum hydrocarbons. In introducing it into emulsions of these oils it is therefore necessary to make use of an additional material in which it is more soluble (12, 13, 14, 16). The preparation of dusts and emulsions containing rotenone will be treated more fully in a subsequent article.

PREPARATION OF AQUEOUS SUSPENSIONS. In experimental work rotenone has generally been applied in the form of aqueous suspensions. A water extract or infusion of fresh Derris root is used extensively as an insecticide on the Malay Peninsula and in the East Indies (1, 7, 15). Tattersfield and Roach (4) state that in preparing suspensions the use of organic solvents appears advisable. They also state that certain of the non-toxic constituents of the fresh root may be valuable as emulsifying agents but, because of the fact that the root as received has dried in transit, the addition of foreign emulsifying agents is necessary. Thus in a subsequent work in conjunction with Fryer and Stenton (5), they produced a more or less permanent suspension by adding an alcohol solution of rotenone (which they called "tubatoxin"), to a solution of saponin in water. Other investigators have added an acetone solution of rotenone to water and used the resulting temporary suspension immediately.

Because of the increasing importance of rotenone as an insecticide, it was thought advisable to make a systematic study of the various means

of suspending this material in water, and to formulate any precautions which it might be necessary to observe in the preparation and use of these suspensions. The study reported in this paper treats primarily of the physical nature of the suspensions obtained. Published entomological tests made by one of the authors will be discussed later in this paper.

Fryer, Stenton, Tattersfield and Roach, in the paper previously mentioned (5), state that the toxicity of the pure poisons found in Derris root appears to depend upon their degree of dispersion. The size of the dispersed particles is certainly of importance in that it affects the wetting and other physical properties of the suspension. In the present work the degree of opacity to light was considered as an approximate indication of the condition of the dispersed rotenone, and is recorded as various degrees of translucency. The length of time during which the majority of the rotenone remained in suspension was also considered as a criterion for a satisfactory dispersion. The preparation of suspensions of rotenone in water was attempted by two general methods: first, the precipitation of the rotenone from its solution in water-soluble solvents by mixing with water; and second, the mixing of preparations of finely powdered, dry rotenone with water. In the majority of the experiments the suspensions were prepared in 100 cc. glass-stoppered cylinders, the volume of the final suspension being 100 cc. This afforded a convenient means of approximating the amount of settling and of comparing the opalescence of the various suspensions.

Preparation of Suspensions from Rotenone Solutions. In preparing suspensions by the first general method, namely, mixing a solution of rotenone in a water-soluble solvent with water, the number of suitable solvents is rather limited. Of these only a few are good solvents for rotenone. Acetone, diacetone alcohol, ethylene chlorohydrin and pyridine all are soluble in water and also dissolve rotenone readily. Alcohol, ethylene glycol and glycerine are miscible with water but are very poor solvents for rotenone. Formic and acetic acids are fair solvents for rotenone and are completely miscible with water, but as will be seen later, permanent suspensions of rotenone are not readily obtained in acid conditions. Such materials as ethyl carbonate, ethyl formate and methyl ethyl ketone, although fair solvents for rotenone, are not sufficiently soluble in water to be of use

It seemed probable that with some solvents the rotenone would form a satisfactory suspension without the addition of a protective colloid. In those cases in which the addition of such a material was necessary, the

protective colloid might be contained in the organic solvent used, in the water to which the rotenone solution was added, or portions dissolved in both the organic solvent and the water.

Suspensions were prepared as follows: A "primary" solution was first made by dissolving the proper quantity of rotenone, and protective colloid in certain cases, in the organic solvent. A measured quantity of this solution was added to the desired volume of water, containing protective colloid in some experiments, and the mixture shaken by inverting the cylinder several times. The physical appearance of the resulting suspension and the time of settling were recorded.

Table 1 shows the results obtained when no protective colloid was used. At a concentration of 0.5 gram of rotenone per liter, acetone, diactone alcohol and pyridine gave suspensions in which the rotenone remained well dispersed for about 24 hours. A suspension made from a pyridine solution at a concentration of 0.1 gram of rotenone per liter (No. 18) showed no separation during a period of more than a month. Permanent, almost transparent suspensions were obtained at a concentration of 0.05 gram of rotenone per liter, with acetone, diacetone alcohol and pyridine as the solvents. Ethylene chlorohydrin also gave a fairly permanent suspension at this dilution.

A series of suspensions (Nos. 23 to 27) made from a more concentrated solution of rotenone in pyridine showed that when the final suspension contained 1 gram of rotenone per liter separation occurred within 24 hours, but at greater dilutions highly permanent suspensions were obtained.

A primary solution of rotenone in a mixture of 90 per cent acetone and 10 per cent pyridine by volume gave lasting suspensions at rotenone concentrations of 0.5 gram per liter or less (Nos. 29 to 33). It was desired to reduce the concentration of pyridine because of its slight alkaline reaction in water and the possibility of its injury to foliage.

Of the solvents tested, pyridine appeared to give the most highly dispersed and lasting suspensions. The acetone-pyridine mixture gave about the same results as pyridine alone. Acetone and diacetone alcohol also gave good results at low concentrations.

The addition of a protective colloid to make more highly dispersed and lasting suspensions from acetone and other solvents was studied. To test the efficacy of various materials for this purpose, the protective materials were dissolved or suspended in water and an acetone solution of rotenone added. As shown in Table 2, 1 gram of the suspending agent to 100 cc. was used and 1 cc. of an acetone solution of rotenone, containing 1 gram per 100 cc. of solution, was added to 99 cc. of this

water solution, or suspension. In the cases of the insoluble or slightly soluble materials, blanks containing no rotenone were run simultaneously for comparison with the rotenone-containing suspensions.

As will be noted, tannic acid gave the most lasting suspension and also one in which the rotenone seemed to be in a high degree of dispersion. The gums, saponin, triethanolamine oleate, potassium oleate, diatomaceous earth and bentonite, also gave fairly permanent suspensions. In the cases of the last two materials the suspensions were opaque, but this was due primarily to the protective material, the rotenone no doubt being in a finely divided condition.

Of the protective colloids tested, tannic acid is the only one that is readily soluble in both water and acetone. This solubility is an advantage in that tannic acid may be incorporated in the primary acetone solution and will not separate when this is added to water. In experiments made to determine the most desirable concentration of tannic acid, this material was dissolved in the acetone together with the rotenone, the solution then being added to water to produce the suspension. Three acetone solutions, each containing 5 grams of rotenone per 100 cc. of solution but with different amounts of tannic acid, were used to make suspensions of various rotenone concentrations (Nos. 49 to 60 in Table 3). In all of these the rotenone remained well dispersed throughout a 15 day period. There was no appreciable difference in permanency or translucency among the suspensions made from the three different stock solutions.

Other stock solutions containing smaller amounts of rotenone with various amounts of tannic acid were used to make suspensions (Nos. 61 to 69). These suspensions were made at a final volume of 1 liter instead of 100 cc. in order to facilitate measurement of the small quantities of primary solution. None of these suspensions showed appreciable settling during the two weeks' standing.

These tests indicate that a highly permanent suspension may be made from an acetone solution of rotenone by the addition of tannic acid, the amount of tannic acid required being only about half that of the rotenone present. In the entomological tests conducted by one of the authors, a solution containing 2 grams of rotenone and 1 gram of tannic acid per 100 cc. of acetone solution was used extensively.

Tannic acid was also used in attempting to make suspensions from solutions of rotenone in other solvents (Table 4). The addition of this material did not materially improve the suspensions made from some of these solvents, and in the case of pyridine actually had a detri-

mental effect. However, with diacetone alcohol and ethylene chlorohydrin lasting suspensions were obtained, comparable to those obtained with acetone.

PREPARATION OF SUSPENSIONS FROM POWDERED MATERIALS. The preparation of suspensions from powdered rotenone preparations was attempted in several ways. In the first place it was necessary to obtain the dry rotenone in a finely-powdered form. To accomplish this the rotenone was dissolved in acetone and precipitated by the addition of water. The rotenone separated as a voluminous, flocculent precipitate which was easily filtered off and on drying was found to be more finely divided than that obtained from grinding the crystalline material. Under the microscope it showed no definite crystalline structure.

This powder alone when mixed with water did not wet well and after shaking separated immediatly (Table 5). Mixtures of this powder with various dry colloidal materials were made by using, first, equal parts of rotenone and the suspending material. Suspensions made from these mixtures were not lasting (Table 5, Nos. 78 to 80). Another series of powders containing 1 part of rotenone to 9 parts of the protective material was made, and these gave more permanent suspensions at a rotenone concentration of 0.1 gram per liter (Table 5, Nos. 81 to 85). Of the materials tested, gum arabic, saponin and bentonite were the most efficient. Tannic acid, found to be one of the best protective colloids for suspending rotenone when precipitated from organic solution, showed poor results by the dry method. It was found that best results were obtained by first making the powder into a thick paste with a small quantity of water and then gradually thinning with water to the desired volume. However, the preparation of 1 part rotenone and 9 parts saponin gave permanent suspensions when the dry powder was merely shaken with water.

Powdered preparations were also made by precipitating the rotenone in the presence of protective materials, such as bentonite and diatomaceous earth suspended in water, and drying the resulting mixture. The object of this procedure was to deposit the rotenone in finely-divided form on the particles of protective colloid. A few suspensions made from these preparations were of the same nature as those obtained from dry powdered mixtures. Owing to difficulties in filtering the wet colloidal material, the dry mix method appears to be preferable.

Some attempts were made to prepare aqueous suspensions by mixing dry precipitated rotenone with water containing a protective colloid in solution or suspension, but this proved unsatisfactory.

EFFECT OF HYDROGEN-ION CONCENTRATION. It was thought that the suspending properties of pyridine solutions of rotenone might depend to some extent upon the slight alkaline reaction of the aqueous solutions of pyridine. Thus a solution of 1 cc. of pure pyridine in 99 cc. of distilled water was found to have a pH of about 8.0; while 5 cc. of pyridine to 95 cc. of distilled water gives a pH of about 8.4. To approximately simulate this pH a very dilute solution of sodium hydroxide was made having a pH of 8.5. To 99 cc. of this was added 1 cc. of an acetone solution containing 1 gram of rotenone per 100 cc. of solution. This gave a suspension of similar translucency and equal permanence to that obtained with an equal quantity of rotenone in pyridine.

A suspension having a pH of 4.9 was made by adding 1 cc. of a pyridine solution containing 1 gram of rotenone per 100 cc. of solution to 99 cc. of distilled water containing 1 cc. of acetic acid. This showed complete separation of suspended material in less than 24 hours.

These results indicate that more permanent suspensions of rotenone are obtained in slightly alkaline media than in acid conditions, when no protective colloid is present to aid in the dispersion. This conclusion has also been reached by H. H. Shepard as indicated in a private communication from him. It is not advisable, however, to make use of such an alkaline condition in the preparation of suspensions because of the possibility of decomposition of the rotenone in such a medium.

USE OF HARD WATER. To test the feasibility of preparing suspensions using hard waters a solution of 0.5 gram $MgSO_4$, 0.5 gram $CaCl_2$ and 0.25 gram $NaHCO_3$ per liter was made to simulate certain types of hard water. This solution had a pH of 8.0, but this slight alkalinity did not improve the suspension (No. 86) made from a 1 per cent acetone solution in the same concentrations as No. 11, as might be expected from the results obtained with the very dilute NaOH solution.

This artificial hard water was used in making suspensions (Nos. 87 to 90) from solutions of rotenone and tannic acid in acetone at the same concentrations as Nos. 52, 54, 55, and 57. These showed separation of solid material within a few hours after preparation. The addition of 1 gram of tannic acid dissolved in the water to which the rotenone solution was added did not materially improve the suspensions (Nos. 91 and 92). It is probable that the calcium and magnesium salts react with the tannic acid to form insoluble tannates. By the addition of sufficient tannic acid this difficulty might be easily overcome. A suspension (No. 93) made with hard water at the same concentrations as No. 71 from a diacetone alcohol solution of rotenone and tannic acid also showed separation

within a few hours. Pyridine solutions gave only temporary suspensions with hard water (Nos. 94 and 95).

Suspensions (Nos. 96 to 100) made from the powdered rotenone preparations (those containing 1 part rotenone to 9 parts protective material) in hard water, particularly those containing the gums and saponin, were much more permanent than those obtained from rotenone solutions.

ENTOMOLOGICAL DISCUSSION. In a previous paper (18) by one of the authors a series of tests with suspensions made from acetone solutions of rotenone was recorded. Freshly prepared aqueous suspensions were found to be highly toxic to aphids, thrips, white fly nymphs and certain other soft-bodied forms of insects such as coleopterous and lepidopterous larvae. Adults of the Japanese beetle, Colorado potato beetle, and Mexican bean beetle were killed when sprayed with more concentrated suspensions. Aqueous suspensions were of little value against squash bugs, red spiders, mealy bugs and roaches.[1] Similar results were obtained when tannic acid was added to the stock solution at the rate of 1 part of tannic acid to 2 parts of rotenone and when an aqueous suspension from a pyridine solution was used. It would appear that aqueous suspensions of rotenone are of definite value in the control of certain types of insects.

LOSS IN TOXICITY. It was found in making the primary solutions for this work that rotenone decomposes in certain organic solvents. The decomposition occurs rapidly in pyridine, less rapidly in an acetone solution containing tannic acid, and only slowly in a pure acetone solution. This change is accompanied by a corresponding loss in toxicity. A subsequent article will discuss this loss in toxicity in more detail. Pure dry rotenone shows no change in toxicity on standing.

CONCLUSIONS

1. Good physical suspensions of rotenone result from the addition of pyridine solutions, or acetone solutions containing tannic acid, to water in the proper concentrations.

2. Satisfactory suspensions may also be obtained from the use of mixtures of precipitated rotenone and suitable dry protective materials such as the gums, saponin or bentonite.

3. Suspensions are more easily obtained in slightly alkaline than in acid media, but the former condition is not advisable due to the sensi-

[1]From other tests made with rotenone and derris extracts prepared with a penetrating carrier as, for example, fish oil, it has been demonstrated that rotenone has a high toxicity to red spiders, mealy bugs and squash bugs, and that in such combinations there is required for control a smaller amount of the active principles of derris than that which in the aqueous suspensions gave negative results.

TABLE 1. SUSPENSIONS WITH NO PROTECTIVE COLLOID

No.	Primary Solution: Solvent	Primary Solution: Rotenone Concentration (grams/100 cc. Solution)	Primary Solution: Solvent Concentration (cc./100 cc.)	Final Suspension: Rotenone Concentration (grams/liter)	Final Suspension: Translucency[1] (An Approximate Measure of the Degree of Dispersion)	Final Suspension: Time of[2] Separation
1	Acetic Acid	1.0	5.0	0.5	Moderately translucent	1 or 2 hours
2	Acetone	1.0	5.0	0.5	Opaque	1 day
3	Diacetone Alcohol	1.0	5.0	0.5	Opaque	1 day
4	Ethyl Formate	1.0	5.0	0.5	———	Immediate
5	Ethylene chlorohydrin	1.0	5.0	0.5	Moderately translucent	Several hours
6	Formic acid	1.0	5.0	0.5	Highly translucent	1 or 2 hours
7	Furfural	1.0	5.0	0.5	———	Immediate
8	Methyl Ethyl Ketone	1.0	5.0	0.5	———	Immediate
9	Pyridine	1.0	5.0	0.5	Nearly opaque	1 day
10	Acetic Acid	1.0	1.0	0.1	Moderately translucent	1 or 2 hours
11	Acetone	1.0	1.0	0.1	Moderately translucent	Several hours
12	Diacetone Alcohol	1.0	1.0	0.1	Moderately translucent	Several hours
13	Ethyl Formate	1.0	1.0	0.1	———	Immediate
14	Ethylene chlorohydrin	1.0	1.0	0.1	Moderately translucent	1 or 2 hours
15	Formic Acid	1.0	1.0	0.1	Moderately translucent	1 or 2 hours
16	Furfural	1.0	1.0	0.1	———	Immediate
17	Methyl Ethyl Ketone	1.0	1.0	0.1	———	Immediate
18	Pyridine	1.0	1.0	0.1	Highly translucent	More than 2 weeks
19	Acetone	1.0	0.5	0.05	Almost transparent	More than 2 weeks
20	Diacetone Alcohol	1.0	0.5	0.05	Almost transparent	More than 2 weeks
21	Ethylene chlorohydrin	1.0	0.5	0.05	Highly translucent	1 week
22	Pyridine	1.0	0.5	0.05	Almost transparent	More than 2 weeks
23	Pyridine	5.0	2.0	1.0	Opaque	1 day
24	Pyridine	5.0	1.0	0.5	Opaque	1 week
25	Pyridine	5.0	0.5	0.25	Nearly opaque	More than 2 weeks
26	Pyridine	5.0	0.25	0.125	Moderately translucent	More than 2 weeks
27	Pyridine	5.0	0.10	0.05	Almost transparent	More than 2 weeks
28	Acetone 90%—Pyridine 10% by volume	5.0	2.0	1.0	Opaque	Several days
29	Acetone 90%—Pyridine 10% by volume	5.0	1.0	0.5	Opaque	2 weeks
30	Acetone 90%—Pyridine 10% by volume	5.0	0.4	0.2	Nearly opaque	2 weeks
31	Acetone 90%—Pyridine 10% by volume	5.0	0.2	0.1	Moderately translucent	More than 2 weeks
32	Acetone 90%—Pyridine 10% by volume	5.0	0.1	0.05	Highly translucent	More than 2 weeks
33	Acetone 90%—Pyridine 10% by volume	5.0	0.05	0.025	Almost transparent	2 weeks

[1]The various degrees of translucency chosen were: opaque, nearly opaque, moderately translucent, highly translucent, almost transparent. [2]An average time at which the majority of the rotenone had separated.

tivity of rotenone to the action of alkalies. It is difficult to obtain permanent suspensions in very hard water.

4. Owing to decomposition of rotenone in certain solvents it is advisable to prepare primary solutions fresh immediately before making the finished suspension; or to make use of dry powdered preparations.

TABLE 2. SUSPENSIONS WITH VARIOUS PROTECTIVE COLLOIDS

Primary Solution: 1 gram of Rotenone per 100 cc. of acetone solution.
Water: Contains 1 gram of protective colloid per 100 cc. of water solution or suspension.
Final Suspensions:
Solvent Concentration: 1 cc. per 100 cc. of suspension.
Rotenone Concentration: 0.1 gram per liter of suspension.
Protective Colloid Concentration: 10.0 grams per liter of suspension.

No.	Protective Colloid (in water)	Final Suspension Translucency	Time of Separation
34	Gum Acacia	Moderately translucent	One week
35	Gum Karaya	Nearly opaque	Several days
36	Gum Ghatti	Moderately translucent	Two weeks
37	Gelatin	Moderately translucent	One day
38	Soluble Starch	Moderately translucent	Several hours
39	Agar Agar	Nearly opaque	One day
40	Saponin	Highly translucent	Several days
41	Tannic Acid	Highly translucent	More than 2 weeks
42	Triethanolamine oleate	Moderately translucent	Several days
43	Ammonium alginate	Moderately translucent	Several hours
44	Potassium oleate	Moderately translucent	Several days
45	Calcium caseinate	Opaque	Several hours
46	Diatomaceous earth	Opaque	Several days
47	Bentonite	Opaque	Two weeks
48	Lithopone	Opaque	Several hours

TABLE 3. SUSPENSIONS MADE WITH ACETONE AS THE SOLVENT AND TANNIC ACID AS THE PROTECTIVE COLLOID

	Primary Solution			Final Suspension			
No.	Rotenone Concn. (grams/100 cc. soln.)	Protec. Colloid Concn. (grams/100 cc. soln.)	Solvent Concn. (cc./100 cc.)	Rotenone Concn. (grams/liter)	Protect. Colloid concn. (grams/liter)	Translucency	Time of Separation
49	5.0	10.0	2.0	1.0	2.0	Opaque	Two weeks
50	5.0	5.0	2.0	1.0	1.0	Opaque	Two weeks
51	5.0	2.5	2.0	1.0	0.5	Opaque	Two weeks
52	5.0	10.0	0.4	0.2	0.4	Nearly opaque	More than 2 weeks
53	5.0	5.0	0.4	0.2	0.2	Nearly opaque	More than 2 weeks
54	5.0	2.5	0.4	0.2	0.1	Nearly opaque	More than 2 weeks
55	5.0	10.0	0.2	0.1	0.2	Moderately translucent	More than 2 weeks
56	5.0	5.0	0.2	0.1	0.1	Moderately translucent	More than 2 weeks
57	5.0	2.5	0.2	0.1	0.05	Moderately translucent	More than 2 weeks
58	5.0	10.0	0.1	0.05	0.1	Highly translucent	More than 2 weeks
59	5.0	5.0	0.1	0.05	0.05	Highly translucent	More than 2 weeks

TABLE 3.—*Continued*

No.	Primary Solution: Rotenone Concn. (grams/100 cc. soln.)	Primary Solution: Protec. Colloid Concn. (grams/100 cc. soln.)	Solvent Concn. (cc./100 cc.)	Final Suspension: Rotenone Concn. (grams/liter)	Final Suspension: Protect. Colloid concn. (grams/liter)	Translucency	Time of Separation
60	5.0	2.5	0.1	0.05	0.025	Highly translucent	More than 2 weeks
61	4.0	2.0	0.25	0.1	0.05	Moderately translucent	More than 2 weeks
62	3.0	3.0	0.33	0.1	0.1	Moderately translucent	More than 2 weeks
63	2.0	2.0	0.5	0.1	0.1	Moderately translucent	More than 2 weeks
64	4.0	2.0	0.05	0.02	0.01	Highly translucent	More than 2 weeks
65	3.0	3.0	0.07	0.02	0.02	Highly translucent	More than 2 weeks
66	2.0	2.0	0.1	0.02	0.02	Highly translucent	More than 2 weeks
67	4.0	2.0	0.025	0.01	0.005	Almost transparent	More than 2 weeks
68	3.0	3.0	0.033	0.01	0.01	Almost transparent	More than 2 weeks
69	2.0	2.0	0.05	0.01	0.01	Almost transparent	More than 2 weeks

TABLE 4. SUSPENSIONS MADE WITH VARIOUS SOLVENTS USING TANNIC ACID AS A PROTECTIVE COLLOID

Primary Solution: 1 gram of Rotenone, 1 gram of Tannic Acid } per 100 cc. of acetone solution.

Final Suspension:

Solvent Concentration: 1 cc. per 100 cc. of suspension.

Rotenone Concentration: 0.1 gram per liter of suspension.

Protective Colloid Concentration: 0.1 gram per liter of suspension.

No.	Primary Solution: Solvent	Final Suspension: Translucency	Final Suspension: Time of Separation
70	Acetic Acid	Almost transparent	Several hours
71	Diacetone Alcohol	Highly translucent	More than 2 weeks
72	Ethyl Formate	———	Immediate
73	Ethylene Chlorohydrin	Nearly opaque	One week
74	Formic Acid	Almost transparent	Several hours
75	Methyl Ethyl Ketone	———	Immediate
76	Pyridine	Nearly opaque	Several days

TABLE 5. SUSPENSIONS FROM POWDERED PREPARATIONS

No.	Primary Powder: Rotenone Concentration (per cent by wt.)	Primary Powder: Protective Colloid	Primary Powder: Protective Colloid Concentration (per cent by wt.)
77	100	None	—
78	50	Tannic acid	50
79	50	Saponin	50
80	50	Bentonite	50
81	10	Gum Acacia	90
82	10	Gum Karaya	90
83	10	Saponin	90
84	10	Tannic acid	90
85	10	Bentonite	90

TABLE 5—*Continued*

No.	Rotenone Concentration (grams/liter)	Final suspension Protective Colloid Concentration (grams/liter)	Translucency	Time of Separation
77	0.1	—	———	Immediate
78	0.1	0.1	———	Immediate
79	0.1	0.1	———	Immediate
80	0.1	0.1	———	Immediate
81	0.1	0.9	Moderately translucent	Two weeks
82	0.1	0.9	Moderately translucent	One week
83	0.1	0.9	Moderately translucent	Two weeks
84	0.1	0.9	Moderately translucent	Several days
85	0.1	0.9	Opaque	Two weeks

TABLE 6. SUSPENSIONS MADE WITH HARD WATER

Water used { 0.5 gm. $MgSO_4$ / 0.5 gm. $CaCl_2$ / 0.25 gm. $NaHCO_3$ } per liter

FROM ORGANIC SOLUTIONS

No.	Solvent	Primary Solution Rotenone Concentration (gm./100 cc. soln.)	Tannic Acid Concentration (gm./100 cc. soln.)	Tannic Acid in the Water (gm./100 cc.)
86	Acetone	1.0	None	None
87	Acetone	5.0	10.0	None
88	Acetone	5.0	2.5	None
89	Acetone	5.0	10.0	None
90	Acetone	5.0	2.5	None
91	Acetone	5.0	2.5	1.0
92	Acetone	5.0	2.5	1.0
93	Diacetone Alcohol	1.0	1.0	None
94	Pyridine	5.0	None	None
95	Pyridine	1.0	None	None

No.	Solvent Concn. (cc./100 cc.)	Final Suspension Rotenone Concn. (gm./liter)	Tannic Acid Concn. (gm./liter)	Translucency	Time of Separation
86	1.0	0.1	None	Moderately translucent	1 to 2 hours
87	0.4	0.2	0.4	Opaque	Several hours
88	0.4	0.2	0.1	Opaque	Several hours
89	0.2	0.1	0.2	Nearly opaque	Several hours
90	0.2	0.1	0.05	Nearly opaque	Several hours
91	0.4	0.2	10.1	Opaque	Several hours
92	0.2	0.1	10.05	Nearly opaque	Several hours
93	1.0	0.1	0.1	Highly translucent	1 to 2 hours
94	0.5	0.25	None	Nearly opaque	Several hours
95	2.0	0.2	None	Moderately translucent	1 to 2 hours

TABLE 6—*Continued*

FROM POWDERED PREPARATIONS

Primary Powder

No.	Rotenone Concn. (% by wt.)	Protective Colloid	Protective Colloid Concn. (% by wt.)
96	10	Gum Acacia	90
97	10	Gum Karaya	90
98	10	Saponin	90
99	10	Tannic Acid	90
100	10	Bentonite	90

Final Suspension

No.	Rotenone Concn. (grams/liter)	Protective Colloid Concn. (grams/liter)	Translucency	Time of Separation
96	0.1	0.9	Moderately translucent	Several days
97	0.1	0.9	Nearly opaque	Several days
98	0.1	0.9	Nearly opaque	One week
99	0.1	0.9	Nearly opaque	Several hours
100	0.1	0.9	Opaque	1 or 2 hours

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CHANGE IN TOXICITY OF ROTENONE IN SOLUTION AND SUSPENSION

By W. M. DAVIDSON, *Insecticide Control, Food and Drug Administration and* HOWARD A. JONES, *Insecticide Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture*

ABSTRACT

Rotenone has been found to decompose at various rates when allowed to stand in solution in certain solvents, the decomposition being evidenced by development of a yellow color and in some cases by separation of certain of the yellow decomposition materials in crystalline form. This change is accompanied by a loss in toxicity to insects as shown by entomological tests made with aqueous suspensions prepared from these solutions. The loss in toxicity occurs most rapidly in pyridine, less rapidly in acetone containing tannic acid and is imperceptible in both acetone and alcohol. The yellow decomposition products separating from pyridine solutions were found to have much less insecticidal activity than pure rotenone.

The aqueous suspensions prepared from acetone and alcohol solutions of rotenone showed only a slight loss in toxicity on standing. Dry rotenone shows no decomposition or loss in toxicity.

During previous work (1) on the solubility of rotenone, it was noted that its solutions in a number of solvents turned from colorless to various depths of yellow on standing. This change occurs very rapidly in pyridine and acetone-tannic acid solutions, less rapidly in chloroform and ethylene dichloride and only slowly in acetone, ethyl alcohol, diacetone alcohol and benzene. It was found that this color change was accompanied by a decrease in optical rotation.

In a previous paper (2) solutions of rotenone in pyridine, in acetone with tannic acid, and in acetone alone were found to give aqueous suspensions that were satisfactory from a physical standpoint. It was thought desirable to make a study of the changes, particularly in regard to toxicity, occurring in these primary solutions.

The decomposition of rotenone in these solutions was found to be accelerated by access of air, but apparently was unaffected by differences in amount of light. It was found further that the first products of the reaction were yellow needle-like, crystalline materials, these crystals forming within a few days in pyridine solutions containing 10–20 grams of rotenone per 100 cc. Needle-like yellow crystals have already been reported by Tattersfield and Roach (3) as resulting from the boiling of alcohol solutions of rotenone. A chemical study of these materials has shown them to be oxidation products of rotenone.[1] From these considerations, it is fairly certain that the decomposition of rotenone taking place in organic solvents is the result of oxidation. It is possible that this decomposition may be prevented or inhibited by the use of certain antioxidants.

That these chemical changes are accompanied by a corresponding loss in insecticidal activity is shown by the following tests[2] made with pyridine, acetone-tannic acid, acetone and ethyl alcohol solutions in the form of aqueous suspensions prepared as described in previous papers (2, 4).

The stock solutions of rotenone in pyridine lost toxicity very rapidly, those with tannic acid in acetone more slowly. Decomposition and resulting lowering of toxicity had almost certainly started before the first tests were made, four days after the stocks were prepared, since numerous tests with fresh acetone solutions at the concentrations of 1:50,000 and 1:25,000 resulted in mortalities of *Myzus persicae* in excess of 95 per cent. Tests on other soft-bodied insects with the pyridine and tannic acid-acetone stocks gave further proof of the loss of toxicity. The results with the acetone and alcohol stock solutions did not indicate a loss in toxicity upon standing. However, it may be assumed that the acetone stock does undergo a small loss on standing because there is a relatively slight change in color. The relative rates of loss in toxicity found in these entomological tests correspond to the rates of the chemical change observed.

The stock solutions used in these tests were kept in tightly stoppered bottles in indirect sunlight at room temperature.

[1]Further chemical work is being done on this decomposition, and a future paper will cover the chemical phases of the subject more thoroughly.

[2]All entomological tests reported in the tables, except the series with the grape leaf hopper, *Typhlocyba comes*, were made in the greenhouse under approximately similar conditions of temperature and humidity. Net mortalities were calculated by comparison with simultaneous controls using the formula described by Abbott. (Jour. Econ. Ent., *18:* 265–267 (1925)).

TABLE 1. LOSS OF TOXICITY IN STOCK SOLUTIONS OF ROTENONE DISSOLVED IN PYRIDINE, ACETONE-TANNIC ACID, ACETONE, AND 95% ETHYL ALCOHOL. TEST INSECT—*Myzus persicae* SULZ. (100–200 INDIVIDUALS). ENVIRONMENT:—POTTED CABBAGE PLANTS IN GREENHOUSE. (SILVER SPRING, MD., 1930)

Solvent	Concentration		Age of Stock Solution	Net Mortality 7-Day Record
	Stock Solution (Grams per 100 cc.)	Spraying Suspension (gram: cc	Days	Per cent
Pyridine	2	1:50,000	4	80.1
			39	0.0
	2	1:25,000	4	90.8
			39	0.0
Acetone Tannic acid	2+1 gm. tannic acid	1:50,000	4	80.4
			39	55.5
	2+1 gm. tannic acid	1:25,000	4	89.5
			39	39.3
Acetone	0.175	*1:100,000	0	99.0
	0.02	1:100,000	1	98.2
	0.02	1:100,000	12	84.4
	0.02	1:100,000	15	90.7
	0.02	1:100,000	22	85.0
	0.02	1:100,000	28	98.9
	0.02	1:100,000	40	96.0
	0.02	1:100,000	42	85.7
	0.02	1:100,000	67	95.2
	0.02	1:100,000	68	99.3
	0.02	1:100,000	77	96.5
Ethyl alcohol 95%	0.25	1:100,000	0	91.1
	0.25	1:100,000	15	89.7
	0.25	1:100,000	19	97.3
	0.25	1:100,000	28	95.2

*At this concentration the toxic action of rotenone is delayed and the final result is that aphids of this species younger than the fourth instar seldom survive, and that about 20 per cent of the fourth instar and 40 per cent of the fifth (adult) instar do survive treatment. It was found that the young produced in the first few days after treatment suffered a heavy mortality. These young did not all die at birth and many of them lived until the first molt. When a sprayed plant was rapidly putting out new leaves all the young deposited on the expanding foliage developed normally. After about the third day the mortality of the young deposited on sprayed leaves dropped off. It may thus be deduced that the rotenone continues to be active on the plant for several days after spraying. The rotenone spray did not check the deposition of young by surviving adults.

Comparative tests showed that at this concentration (.001) rotenone was slightly more toxic to *Myzus persicae* Sulz. under greenhouse conditions than aqueous nicotine .02 and slightly less toxic than .01 nicotine with .5 fish oil soap.

The control insects were sprayed with dilutions of the respective solvents, except that water alone was used as a check for the suspensions from acetone solutions.

Some of the yellow crystalline materials separated from a pyridine solution were redissolved in acetone at the rate of 0.20 gram per 1 liter of solution. This solution was used to make suspensions at concen-

trations of 1:10,000 to 1:100,000. The following table shows the toxicity of this material against various insects as compared with suspensions of like concentrations from a corresponding solution of pure rotenone.

TABLE 2. COMPARATIVE TOXICITY OF ROTENONE AND YELLOW DECOMPOSITION MATERIAL. TEST INSECTS AND ENVIRONMENT: *Typhlocyba comes* ON GRAPE IN FIELD, *Brevicoryne brassicae* AND *Pontia rapae* ON POTTED CABBAGE PLANTS IN GREENHOUSE (SILVER SPRING, MD., 1930)

Solvent: Acetone.
Concentration of Stock Solution: 0.02 gram per 100 cc.

Concentration Spraying Suspension (gram: cc.)	Species of Insect and Per cent Net Mortality					
	Typhlocyba comes, Nymphs (30–50 Individuals)		*Brevicoryne brassicae* K. (100–200 Individuals)		*Pontia rapae* L. Larvae (8–10 Individuals)	
	Rotenone	Yellow Decomp. Material	Rotenone	Yellow Decomp. Material	Rotenone	Yellow Decomp. Material
1:100,000	94.2	0.0	98.5	40.8	——	—
1:50,000	——	8.9	——	——	100.0	0.0
*1:25,000	——	—	——	43.7	——	0.0
*1:12,500	——	—	——	11.6	——	0.0
*1:10,000	——	—	——	17.3	——	—

*The stock solutions from which these tests were made were from 7 to 17 days old

From these results it is apparent that the yellow materials are much less toxic than rotenone itself to the species of insects tested.

The yellow crystals were also tested against goldfish by W. A. Gersdorff of the Insecticide Division according to the method used by him in the testing of rotenone (5). After 24 hours in a solution of a concentration of 0.2 mgm. per liter the fish were unaffected.

In most cases it will not be necessary to keep the final aqueous suspensions, made from the stock solutions discussed above, over an extended period of time. However, it is of interest to know whether any decomposition occurs in them on standing. Such suspensions show no apparent chemical decomposition of the rotenone on long standing. Due to the small quantities of rotenone involved, however, toxicological tests are more reliable. Table 3 shows the results obtained on certain insects with the same suspensions at various intervals after their preparation from fresh stock solutions of acetone and ethyl alcohol.

After standing for more than a week in sprayers exposed to slight evaporation, these suspensions had lost little of their toxicity to *Myzus persicae* and *Brevicoryne brassicae*. Loss in toxicity was evident when the test insect was the larva of *Pontia rapae*. When a suspension made from an acetone solution, which itself had stood twelve days, was allowed to stand in a beaker lightly covered with a petri dish, rapid loss in toxicity was evident in the case of all three insects. H. H. Shepard,

using *Aphis rumicis* as the test insect, has also found that rotenone undergoes loss in toxicity when allowed to stand in aqueous suspensions prepared from alcohol solutions.[3]

TABLE 3. LOSS OF TOXICITY IN SPRAYING SUSPENSIONS MADE FROM STOCK SOLUTIONS OF ROTENONE IN ACETONE AND IN 95% ETHYL ALCOHOL. pH OF WATER 7.1. ENVIRONMENT:—POTTED CABBAGE PLANTS IN GREENHOUSE (SILVER SPRING, MD., 1930)

Solvent	Concentration: Stock Solution (grams per 100 cc.)	Concentration: Spraying Suspension (Gram: cc.)	Period over which Suspension was Standing Hours	Species of Insect: *Myzus persicae* (100–200 individuals) Net Mortality 1 day	*Myzus persicae* 7 days	*Brevicoryne brassicae* (100–200 individuals) Net Mortality 1 day	*Brevicoryne brassicae* 7 days	*Pontia rapae* (8–10 individuals) Larvae in Penultimate Instar Net Mortality
				Per cent		Per cent		Per cent
Acetone.....	0.175	[1]1:100,000	0	75.8	99.0	71.6	100.0	85.7
	——	——	48		98.9		100.0	51.0
	——	——	144	55.4	87.2		——	——
	——	——	192		——		——	20.0
	——	——	240		97.0		100.0	——
Acetone.....	0.02	[2]1:100,000	0		84.4		97.0	85.7
	——	——	24		71.0		80.2	71.4
	——	——	48		64.1		67.6	16.7
	——	——	72		——		35.1	0.0
Ethyl Alcohol	0.25	[2]1:100,000	0	48.8	91.1	89.0	96.7	——
	——	——	5	48.4	95.7	88.1	100.0	——
	——	——	24	46.5	97.7	22.4	77.6	——
	——	——	72	46.9	90.5		——	——
	——	——	126	38.7	74.4	15.6	87.9	28.6
	——	——	224	43.9	93.8		——	——
	——	——	312		——		——	33.3
	——	——	528	23.6	79.5		——	——
Ethyl Alcohol	0.25	[3]1:100,000	0		89.7		——	——
	——	——	4		——		91.0	——
	——	——	48		89.3		——	——
	——	——	76		88.1		——	——

[1]Diluted from fresh stock solution. Suspension allowed to stand in sprayer with metal pump tightly screwed on. 500 cc. water in check sprayer evaporated 2.8 per cent in 360 hours.

[2]Diluted from stock prepared 12 days previous. Suspension allowed to stand in beaker with petri dish for cover. 200 cc. water in check beaker evaporated 4.5 per cent in 144 hours.

[3]Diluted from stock prepared 15 days previous. Suspension in sprayer as in footnote 1.

This loss in toxicity may be due partly to the increase in size of the rotenone particles on standing in colloidal suspensions of this nature. It may also be due to a slight decomposition of the rotenone itself.

[3]Private communication from H. H. Shepard, Bureau of Entomology, Takoma Park, Md.

There is no reason to believe that dry powdered preparations of rotenone will show any decomposition on standing. Thus a sample of pure rotenone prepared in July 1929 and tested at that time for optical activity and for toxicity against fish and in January 1930 tested for toxicity against insects showed the same optical rotation, piscicidal and insecticidal activity when again tested in October 1930. It is reasonable to suppose that dry mixtures of rotenone and colloidal materials will keep indefinitely.

Conclusions

1. Rotenone in pyridine solution and in acetone solution with tannic acid shows definite loss of toxicity upon standing. No loss in activity was detected in the acetone and the alcohol stock solutions.

2. The yellow decomposition material obtained from a pyridine stock solution was much less toxic to the insects and fish upon which it was tested than pure rotenone.

3. A loss of toxicity of rotenone on standing in aqueous suspensions made from fresh acetone and alcohol stock solutions was noted.

Recommendations. It is recommended from the results given in this paper that stock solutions in pyridine and in acetone with tannic acid for use in making aqueous suspensions be used immediately after preparation.

Solutions in acetone and ethyl alcohol may be allowed to stand a limited time without loss in toxicity.

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THE INCOMPATIBILITY OF LIME WITH FLUOSILICATES

By R. H. CARTER, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

ABSTRACT

A discussion of the composition and chemical properties of the fluosilicates in relation to their insecticidal use and possible injury to foliage is presented. The effects of the addition of hydrated lime to sodium, potassium, and barium fluosilicates in order to reduce their acidity in solution was studied on mixtures ranging in proportions from one to twenty parts of lime per ten parts of fluosilicate. It was found that the addition of small amounts of lime materially decreased the solubility of the fluosilicates probably due to the introduction of a common ion from the reactions. Strongly alkaline solutions were formed when an excess of lime was present due to further reactions.

Considerable experimental work has been done in the last few years in a study of the efficacy and methods of application of the fluosilicates for the control of insect pests of field crops. Barium, potassium, and sodium fluosilicates, being the least soluble, have given the best results but in many cases even these have caused severe burning of foliage and fruit. A knowledge of the composition and chemical properties of the fluosilicates explains why this might be expected, especially in regions where rainfall is abundant or dews are heavy.

Silicon tetrafluoride, SiF_4, reacts with water according to the equation $3SiF_4 + 4H_2O \longrightarrow 2H_2SiF_6 + Si(OH)_4$ to form hydrofluosilicic acid, H_2SiF_6, which may also be regarded as a combination of hydrofluoric acid with silicon tetrafluoride and written as $2HF.SiF_4$. When the hydrogen ions are replaced by a metal as for instance, sodium, we have the compound $2NaF.SiF_4$ or sodium fluosilicate, Na_2SiF_6, as it is commonly written. Because of the hydrolysis of this compound in water according to the equation $3Na_2SiF_6 + 4H_2O \rightleftharpoons 6NaF + 2H_2SiF_6 + Si(OH)_4$ an acid reaction is developed which corresponds in a saturated solution to a pH value of approximately 3.1. Most fluosilicates may be considered as a combination of 1 molecule of silicon tetrafluoride with two atoms of fluorine attached to a metal so that all, therefore, give an acid reaction. In using fluosilicate sprays for instance at the rate of 4 lbs. per 100 gallons the total available acid calculated to their equivalents in sulfuric acid is as follows:

4 lbs. Na_2SiF_6 = 4.16 lbs. H_2SO_4
4 lbs. K_2SiF_6 = 3.56 lbs. H_2SO_4
4 lbs. $BaSiF_6$ = 2.81 lbs. H_2SO_4

Solutions of these compounds for this reason may be titrated with standard solutions of alkali and such a procedure is generally employed for their analysis. The complete reaction may be written:

$3Na_2SiF_6 + 4H_2O + 12NaOH \longrightarrow 18NaF + 3Si(OH)_4 + 4H_2O$ or $Na_2SiF_6 + 4NaOH \longrightarrow 6NaF + Si(OH)_4$ as it is commonly written.

In an attempt to neutralize this acidity and eliminate burning of the foliage and also to improve the physical condition of the fluosilicates for dusting purposes, many investigators have advocated the addition of hydrated lime to the fluosilicates in proportions ranging from one to ten or more parts.

Hucket (J. Econ. Ent., 22, 405, 1929) has reported that sodium fluosilicate and lime dusts when dry were effective in the control of the cucumber beetle.

Hinds and Spencer (J. Econ. Ent., 20, 352, 1927) have carried on extensive experiments on the control of the sugarcane borer with sodium fluosilicate with and without the addition of lime. They found that ten per cent of hydrated lime decreased the burning effect.

Chapman and Gould (J. Econ. Ent., 23, 197, 1930) conducted extensive experiments on the use of the fluosilicates with and without lime on cucumbers.

Freborn and Wymore (J. Econ. Ent., 22, 667, 1929) reported that sodium fluosilicate (95 per cent) plus equal parts of hydrated lime was effective against the corn ear worm.

Fleming (J. Econ. Ent., 20, 685–91, 1927) conducted extensive tests in the control of the Japanese beetle by fluosilicates and included a study of their properties, compatibilities with other insecticides, and use of diluents.

Eddy and McAlister (S. Car. Agr. Exp. Sta. Bull., 236, 1927) studied the control of the Mexican bean beetle by fluosilicates and the effect of the fluosilicates with and without diluents on foliage.

Baerg (Ark. Agr. Exp. Sta. Bull., 201, 1925) found that sodium fluosilicate and hydrated lime was effective in the control of blister beetles and showed no appreciable injury on soy beans, lucerne, potatoes and tomatoes.

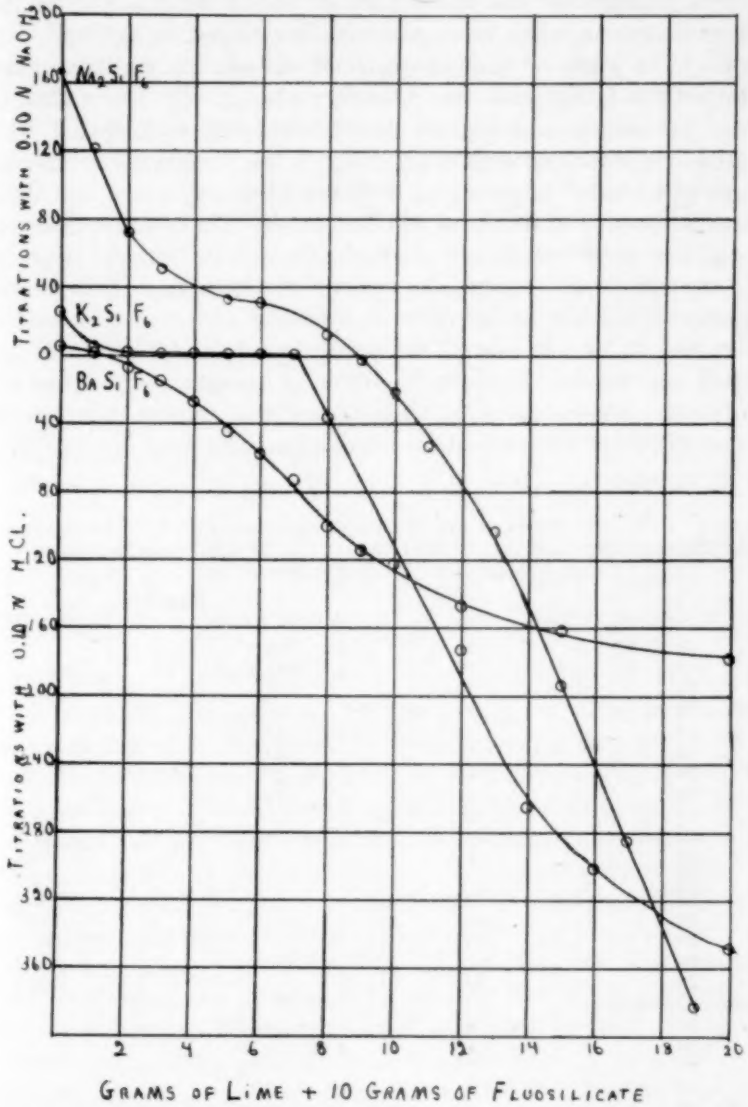
Marcovitch (Tenn. Agr. Exp. Sta. Bull., 131, 1924, and Tenn. Agr. Exp. Sta. Circ. 1 and 8 and other publications) recommends the use of fluosilicates for the control of Mexican bean beetle and other insect pests and used as high as nine parts of hydrated lime to one part sodium fluosilicate. Many other references are also available.

Hydrated lime has an appreciable solubility in water, giving an alkaline reaction, so that the following reaction takes place in the presence of water:

$$Na_2SiF_6 + 2Ca(OH)_2 \longrightarrow 2NaF + 2CaF_2 + Si(OH)_4$$

A further reaction also takes place resulting in the precipitation of in-

soluble calcium fluoride and the formation of a sodium hydroxide solution. This process has actually been made the basis for a patent in the preparation of sodium hydroxide (Chem. Trade J. and Chem. Eng.,



No. 2180, LXXXIV, 201, 1929). This equation is written $2NaF + Ca(OH)_2 \longrightarrow CaF_2 + 2NaOH$, and the complete equation may be written as $Na_2SiF_6 + 3Ca(OH)_2 \longrightarrow 3CaF_6 + 2NaOH + Si(OH)_4$.

In this case the resulting alkaline solution may be as harmful to vegetation as the previously described acid solution.

A chemical study of the equilibrium of various mixtures of hydrated lime with fluosilicates was undertaken to obtain information on the reactions occurring when these materials are mixed in different proportions. The acidic or basic character of the solution was considered the important factor and was therefore chosen for determination. Barium, potassium, and sodium fluosilicates were each mixed with hydrated lime in proportions of 10 grams of the fluosilicate to varying amounts of hydrated lime ranging from one to twenty grams and these mixtures suspended in 200 cc. of distilled water. The reaction mixtures were agitated mechanically for one hour, allowed to stand 24 hours or longer, samples taken, filtered, and titrated with standard alkali or acid using phenolphthalein as indicator in a boiling solution. The results calculated in cc. of 0.10 normal sodium hydroxide and 0.10 normal hydrochloric acid required to neutralize 100 cc. of the saturated solution are given below. These figures, plotted against the number of grams of lime per 10 grams of fluosilicate are shown graphically by curves (Page 265).

TABLE 1. CONCENTRATIONS OF FLUOSILICATES AND LIME IN 200 C.C. OF WATER AND TITRATIONS OF 100 C.C. OF SOLUTION IN C.C. OF 0.10 NORMAL SODIUM HYDROXIDE AND HYDROCHLORIC ACID

		Titrations	
Sodium Fluosilicate	Lime	0.10 N NaOH	0.10 N HCl
10	0	166.0	
10	1	121.0	
10	2	71.6	
10	3	50.4	
10	4	42.9	
10	5	32.5	
10	6	31.4	
10	8	11.9	
10	9		2.6
10	10		21.2
10	11		54.4
10	12		62.2
10	13		103.6
10	14		150.2
10	15		193.7
10	17		284.9
10	19		383.3
Potassium Fluosilicate			
10	0	25.32	
10	1	4.76	
10	2	1.72	
10	3	1.16	
10	4	1.16	
10	5	0.88	
10	6	0.88	
10	7	0.64	
10	8		51.64

TABLE 1.—*Continued*

		Titrations	
Potassium Fluosilicate	Lime	0.10 N NaOH	0.10 N HCl
10	10		114.2
10	12		172.8
10	14		265.8
10	16		302.2
10	20		348.7
Barium Fluosilicate			
10	0	5.12	
10	1	1.59	
10	2		7.70
10	3		15.40
10	4		29.1
10	5		45.4
10	6		59.4
10	7		73.9
10	8		101.5
10	9		115.3
10	10		122.6
10	12		147.4
10	15		162.4
10	20		177.6

The materials used in these experiments were of the following percentage purity and equivalence:

Sodium fluosilicate			99.4 per cent Na_2SiF_6
"	"	10 g. $\Rightarrow$	8.67 g. lime
Potassium	"		96.0 per cent K_2SiF_6
"	"	10 g. $\Rightarrow$	7.14 g. lime
Barium	"		88.0 per cent $BaSiF_6$
"	"	10 g. $\Rightarrow$	5.16 g. lime
Lime			90.4 per cent $Ca(OH)_2$

It is noticed that in the case of both sodium and potassium fluosilicate the addition of small amounts of lime decreases the number of cc. of alkali required to neutralize 100 cc. of solution and that the curve then flattens out and the solution becomes neutral at approximately the number of grams of lime required to neutralize the total amount of fluosilicate. These points are shown on the curves by crosses. From then on the solutions become increasingly alkaline due to the formation of sodium or potassium hydroxide from the previously described reaction, i. e., $2NaF + Ca(OH)_2 \longrightarrow CaF_2 + 2NaOH$. It is noticed that the total alkalinity developed in solution is less than that expected from the reactions between the lime and the fluosilicates. There are two possible explanations of this, i. e., the formation of an insoluble basic fluoride or a complex silicate-fluoride, but this point has not been investigated. In the case of barium fluosilicate we have a similar curve, but the solution becomes alkaline at a point considerably below the theoretically

neutral point. The explanation of this is probably connected with the low solubility of both barium fluosilicate and barium fluoride. In the conditions here outlined there is an excess of fluosilicate over that required for a saturated solution so that samples taken for analysis may be considered as corresponding to solutions actually occurring when dew or moisture condenses on plants which have been dusted with fluosilicates or mixtures of fluosilicates with lime. The initial decrease in solubility due to the addition of small amounts of lime probably accounts for the elimination of burning without materially decreasing the toxicity of the fluosilicate as has been reported in considerable entomological literature. However, it would not seem advisable to use large amounts of lime in conjunction with the fluosilicates because of the decrease in the available amount due to neutralization.

THE EFFECT OF SOAP ON THE TOXICITY OF A PYRETHRUM PRODUCT KNOWN AS "RED ARROW"[1]

By A. E. BADERTSCHER, M. S., *Research Assistant, New Jersey Agricultural Experiment Station*

ABSTRACT

A study of the toxicity of "Red Arrow" at varying concentrations, of potassium cocoanut fatty acid soap at varying concentrations, and of mixtures of "Red Arrow" and additional soap with "Red Arrow" variable and soap constant, and with soap variable and "Red Arrow" constant. All tested on the green spiraea aphis (*Aphis spiraecola* Patch). The results indicate that "Red Arrow" diluted with tap-water does not function at its maximum efficiency, probably because the surface tension of the aqueous carrier is too high to permit sufficient penetration into the internal tissues of the insect through the breathing system. This study further indicates that the efficiency of "Red Arrow" is increased almost four times when diluted with water containing enough soap (0.4%) to condition the aqueous carrier to very nearly 30 dynes.

A study of the relative toxicity of samples of "Red Arrow" manufactured in 1927, 1928, 1929, and 1930 respectively, kept under normal storage conditions and tested October, 1930 on honey bees (*Apis mellifera* Linn.) and on the black bean plant louse (*Aphis rumicis* Linn.) This study shows that the various samples of "Red Arrow" tested have lost very little if any of their toxicity.

This investigation has been concerned with the effect of soap on a commercial pyrethrum product. The first phase of this problem takes up the increase in toxicity of the unit charge of pyrethrins, while the second phase is devoted to the study of the effect of soap on the toxicity of this pyrethrum product when kept under normal storage conditions over a period of several years.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

The samples of the commercial pyrethrum product used in this investigation that were manufactured in 1927, 1928, and 1929 consist of 40% of a five-fold oleoresin of pyrethrum, 30% potassium cocoanut fatty acid soap, 5% alcohol and the balance water. The 1930 sample was manufactured according to the previously mentioned formula with the exception that in this case 15% of the potassium cocoanut fatty acid soap was replaced with 15% sulphonated oleic acid. By the term five-fold oleoresin is meant that one pound of the oleoresin is the material extracted from five pounds of flowers. The flowers (*Pyrethrum cinerariaefolium*) are the source of the toxic principle (pyrethrins) in this particular product. The additional soap used in the diluted spray material was in all cases a neutral potassium cocoanut fatty acid soap.

The first part of this problem is divided into four parts. (1) A study of the toxicity of "Red Arrow" at varying concentrations. (2) A study of the toxicity of potassium cocoanut fatty acid soap. (3) A study of the toxicity of "Red Arrow" at varying concentrations diluted with water containing a constant amount of soap. (4) A study of the toxicity of soap at varying concentrations diluted with water containing a constant amount of "Red Arrow." These materials were tested in the laboratory under as nearly uniform conditions as was possible, the insect used was the green spiraea aphis (*Aphis spiraecola* Patch).

The second part of the investigation consists of a study of the relative toxicity of samples of "Red Arrow," kept under normal storage conditions, manufactured in the years 1927, 1928, 1929, and 1930 respectively. The tests were made on the honey bee (*Apis mellifera* Linn.) and on the black bean plant louse (*Aphis rumicis* Linn.).

EXPERIMENTAL. In considering the first phase of the problem of the effect of soap on a commercial pyrethrum product, it seemed that the toxicity of the unit charge or dose could be most practicably increased by bringing the toxic material in closer contact with the soft internal tissues of the insect. McGovran (1) has shown that such results could be obtained with nicotine by conditioning the surface and interfacial tensions of the aqueous carrier through the practice of dissolving soap in it. The same principle is brought out by the findings of Nelson (2) who showed that oil readily spread on the insect's integument, had a low surface tension and penetrated the breathing system.

Inasmuch as there was soap already present in "Red Arrow, "it became necessary to determine the toxicity of "Red Arrow" first, then to determine what part soap played in this toxicity, whether it was

acting as an insecticide itself or merely as the conditioner of the carrying aqueous vehicle.

In the study of the toxicity of "Red Arrow" green spiraea aphis (*Aphis spiraecola* Patch) was employed as the biological indicator. The results of this study are set forth in Table 1.

TABLE 1. TOXICITY OF "RED ARROW" WHEN TESTED AT VARYING CONCENTRATIONS ON GREEN SPIRAEA APHIS (*Aphis spiraecola* PATCH)

Dilution of Red Arrow	Total Number	Number Dead	Number Alive	Per Cent Kill	Surface Tension
1–500	1387	1267	120	91	37.1
1–1000	1518	1146	372	76	40.9
1–1500	1500	808	692	54	44.3
1–2000	1355	675	680	50	45.9
1–2500	1402	558	844	40	48.3
1–3000	1546	497	1049	32	50.4
1–3500	1472	331	1141	23	51.4
1–4000	1408	307	1101	22	51.9
1–4500	1369	240	1129	18	52.7
1–5000	1175	143	1032	12	53.2
Check-lots sprayed with tap-water	451	17	434	3.7	

This table shows that the maximum kill is obtained with the maximum strength of pyrethrum and incidentally with the minimum surface tension of the carrying liquid. A further study of this table, however, shows that the varying percentage of kill is not proportional to the varying strength of pyrethrins nor is it proportional to the varying strengths of soap. These conclusions are set forth in Figure 15 in a curve represented with a solid line. The kill of plant lice may be attributed to the pyrethrum or to the soap or to a combination of the two.

The second step was then taken and a study made of the toxicity of soap. The results of this study are set forth in Table 2.

TABLE 2. TOXICITY OF POTASSIUM COCOANUT FATTY ACID SOAP WHEN TESTED AT VARYING CONCENTRATIONS ON GREEN SPIRAEA APHIS (*Aphis spiraecola* PATCH)

Concentration of Soap	Total Number	Number Dead	Number Alive	Per Cent Kill	Surface Tension
1.0%	1557	1466	91	94	30.9
0.8%	1365	1183	182	87	29.9
0.6%	1123	874	249	78	29.9
0.5%	1161	841	320	72	29.9
0.4%	869	522	347	60	29.9
0.3%	1362	671	691	49	30.2
0.2%	1220	501	719	41	31.4
0.1%	1724	351	1373	20	33.2
Check lots sprayed with tap-water	365	15	350	4.1	

This table shows that the maximum percentage of kill was obtained with the maximum strength of soap. Furthermore, the surface tension factor, as a conditioner of the aqueous carrier, shows very little variation and the increasing or decreasing kill must, therefore, be charged to the soap as an insecticide.

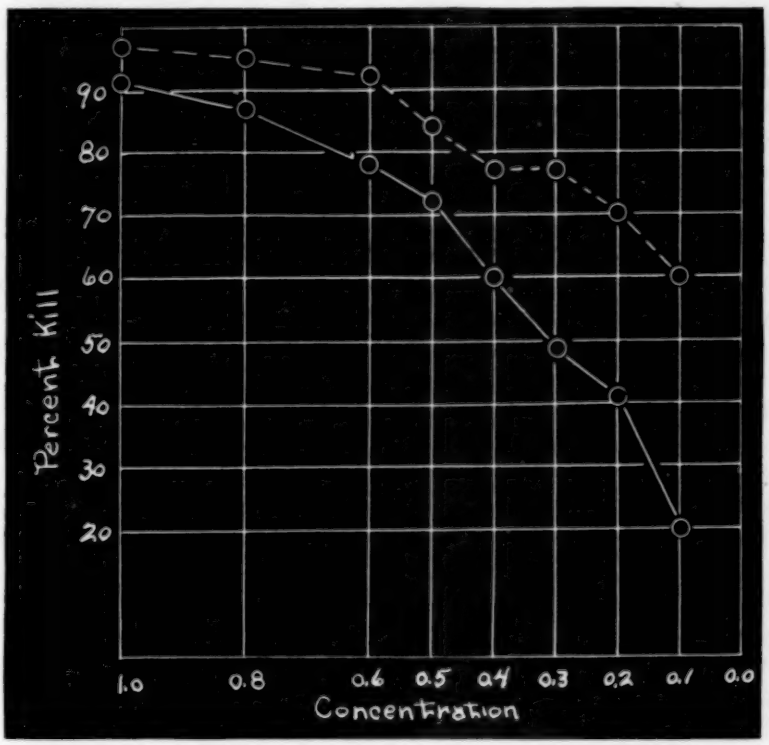


FIG. 14.—Summaries of Tables 2 and 4 showing the kill of the Green Spiraea Aphis (*Aphis spiraecola* Patch) 24 hours after spraying. The solid line represents the kill for cocoanut fatty acid soap at a variable concentration and the broken line represents the kill for cocoanut fatty acid soap at a variable concentration plus "Red Arrow" 1–4000.

In order to determine just what part the strength of pyrethrins play, it then seemed necessary to make a study of varying amounts of pyrethins, using exactly the same amount of soap and that amount of soap is the quantity which would give a surface tension of approximately thirty dynes. This was done by adding enough soap to the water in which the dilutions of "Red Arrow" were made to obtain a constant concentration of soap (0.4%). The results of this study are set forth in Table 3.

TABLE 3. TOXICITY OF "RED ARROW" WHEN TESTED AT VARYING CONCENTRATIONS ON GREEN SPIRAEA APHIS (*Aphis spiraecola* PATCH). DILUTED WITH WATER CONTAINING 0.4% COCOANUT FATTY ACID SOAP

Dilution of Red Arrow	Total Number	Number Dead	Number Alive	Per Cent Kill	Surface Tension
1–500	2053	2017	36	98	30.8
1–1000	1472	1391	81	95	30.8
1–1500	1208	1115	93	92	30.8
1–2000	1465	1306	159	89	30.8
1–2500	1123	968	155	88	30.8
1–3000	2133	1832	301	86	30.8
1–3500	1187	989	198	83	30.8
1–4000	1246	974	272	78	30.8
1–4500	1723	1291	432	75	30.8
1–5000	1525	1098	427	72	30.8
Check-lots sprayed with tap-water	359	79	280	22	

This table shows a range of tests from a given strength of pyrethrum to ten times that strength while the variation in kill shows a range from a given kill of 72% to 1.36 times. A dilution of 1 to 500 "Red Arrow" gives a kill of 91% in Table 1 as compared with 98% in Table 3 while a dilution of 1 to 5000 in Table 1 gives a kill of 12% as compared with a kill of 72% in Table 3. If we subtract the 0.4% soap kill of 60% from the 1 to 500 dilution and the 1 to 5000 dilution in Table 3 we find a range of toxicity for pyrethrin of from 12 to 38%. Dilution 1 to 4000 in this table gives a 78% kill. When this dilution is compared with 0.4% soap in Table 2 the percentage of kill is 60. By subtracting the soap kill of 60% in Table 2 from the pyrethrum soap kill at dilution 1 to 4000 in Table 3 we find the pyrethrum kill as 18%.

In order to see how far this evaluation of pyrethrum kill would extend, a still further study was made using "Red Arrow" constant and soap variable. "Red Arrow" was used at a constant dilution of 1 to 4000. The results are shown in Table 4.

TABLE 4. TOXICITY OF POTASSIUM COCOANUT FATTY ACID SOAP WHEN TESTED AT VARYING CONCENTRATIONS ON GREEN SPIRAEA APHIS (*Aphis spiraecola* PATCH). DILUTED WITH WATER CONTAINING "RED ARROW" 1–4000

Concentration of Soap	Total Number	Number Dead	Number Alive	Per Cent Kill	Surface Tension
1.0%	1312	1266	46	97	31.3
0.8%	1198	1137	61	95	30.8
0.6%	1299	1189	110	92	30.8
0.5%	1592	1388	204	84	30.8
0.4%	1037	800	237	77	30.8
0.3%	1179	911	268	77	30.8
0.2%	998	696	302	70	31.8
0.1%	765	459	306	60	31.8
Check-lots sprayed with tap-water	231	23	208	9.9	

When we examine the soap dilution of 0.4% we find a kill of 77%. Substracting the soap kill in Table 2 at 0.4% concentrations from the 77% kill set forth in Table 4 at a soap concentration of 0.4% we find the pyrethrum kill indicated as 17%. Thus it appears that attacking the matter from either of the two angles the pyrethrum kill evaluation is about the same.

In view of these results it might seem that the wise practical procedure is simply to use more soap because soap is cheaper than pyrethrum but the general upper limit for safe soap concentration in spray mixtures on foliage is 0.5%. It is, therefore, unsafe in general to depend on soap kill at a point higher than 0.5% and on many plants it is unsafe to use even that concentration. We are, therefore, driven to the use of a soap concentration in general not much exceeding 0.4% and to make up the balance of the necessary toxicity by increasing the concentration of pyrethrins.

Re-examination of Table 1 shows that at 1 to 4000 dilution there is a kill obtained with "Red Arrow" of 22%. When this result is compared with the kill obtained at the same dilution but with a soap strength of 0.4% it is found that the kill ranges from 77 to 78%. By the use of this concentration of soap, namely 0.4%, the toxicity of the pyrethrum dosage at 1 to 4000 is increased 3.5 times.

The above results are drawn from laboratory studies and have been found not to hold fully the same in the field. Filmer (4) showed this in the case of nicotine, soap and water mixtures that it was necessary to use approximately twice as great a strength of nicotine for successful results in the field as was necessary for successful results in the laboratory. The writer has found approximately the same ratio to hold in greenhouse spraying with pyrethrum soap as Filmer found in field spraying with nicotine soap. He has found a satisfactory control to result from thorough spraying with a pyrethrum concentration of 0.02% oleoresins which is obtained by a dilution of "Red Arrow" of 1 to 2000 with a soap content adjusted to 0.4% concentration.

The second part of this investigation is concerned with a study of the effect of soap on a pyrethrum product which has been on the market for number of years. It has been stated that "Red Arrow" contains 30% soap, therefore it is entirely reasonable to ask the question whether this amount of soap will destroy the pyrethrins over a period of several years. Roark (3) sets forth the principle that pyrethrum and soap are a chemically incompatible mixture. From a practical standpoint it seems that by a chemically incompatible mixture he means that such a mixture loses more or less rapidly its toxic power as an insecticide. The

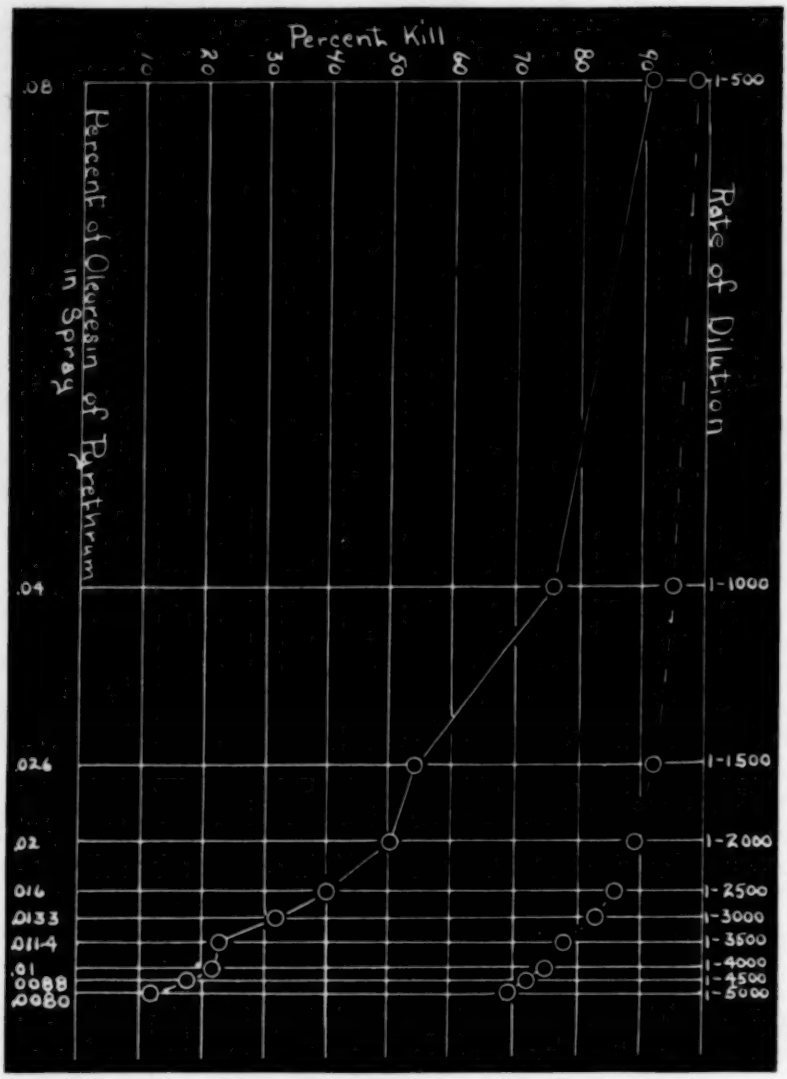


FIG. 15.—Summaries of Tables 1 and 3 showing the kill of the Green Spiraea Aphis (*Aphis spiraecola* Patch) 24 hours after spraying. The solid line represents the kill for "Red Arrow" at variable concentrations, the broken line for "Red Arrow" at variable concentrations plus constant 0.4% cocoanut fatty acid soap.

writer concludes from some of his, as yet, unpublished data that very dilute solutions of pyrethrum soap sprays lose an appreciable amount of their toxicity if left standing over a period of ten hours. Since the common practice is to use spray solutions and suspensions as soon as they have been made ready, the practical problem of loss in toxicity is not concerned with dilute solutions but the concentrated forms in which they are normally stored for long periods of time.

Inasmuch as the commercial product "Red Arrow" represents an aqueous mixture of oleoresins of pyrethrum and soap in the percentages of 40 and 30 respectively it seemed wise to determine whether passing time was correlated with the reduction in toxicity. Samples of "Red Arrow" manufactured in 1927, 1928, 1929, and 1930 were compared. These materials were tested simultaneously on honey bees (*Apis mellifera* Linn.) and on the black bean plant louse (*Aphis rumicis* Linn.). The results are set forth in Table 5.

TABLE 5. SHOWING THE RELATIVE TOXICITY OF SAMPLES OF "RED ARROW" MANUFACTURED IN 1927, 1928, 1929 AND 1930 RESPECTIVELY

Tested on Honey Bees, *Apis mellifera*. "Red Arrow" was Used at a Constant Dilution of 1–4000, Diluted with Water Containing 0.1% Soap.

Year	Total Number	Number Dead	Number Alive	Per Cent Kill
1927	969	770	199	80
1928	1113	948	165	85
1929	975	851	124	88
1930	824	667	157	81
0.1% Soap	791	148	643	18.6
Tap-Water	748	21	727	2.8

Tested on *Aphis rumicis*. "Red Arrow" was Used at the Rate of 1–1000, Diluted with Water Containing no Soap

Year	Total Number	Number Dead	Number Alive	Per Cent Kill
1927	485	303	182	64
1928	723	486	237	67
1929	268	200	68	75
1930	639	461	178	72
Check-lots sprayed with tap-water	540	64	476	12

Tested on *Aphis rumicis*. "Red Arrow" was Used at the Rate of 1–2000, Diluted with Water Containing no Soap

Year	Total Number	Number Dead	Number Alive	Per Cent Kill
1927	340	173	167	51
1928	565	288	277	51
1929	456	244	212	54
1930	794	443	351	56
Tap-Water	620	51	569	8.2

The first section of this table is concerned with honey bees and shows no appreciable diminution in toxicity. The second section of this table is concerned with a test of "Red Arrow" 1 to 1000 on the black bean plant louse (*Aphis rumicis* Linn.) and shows very little, if any, diminution.

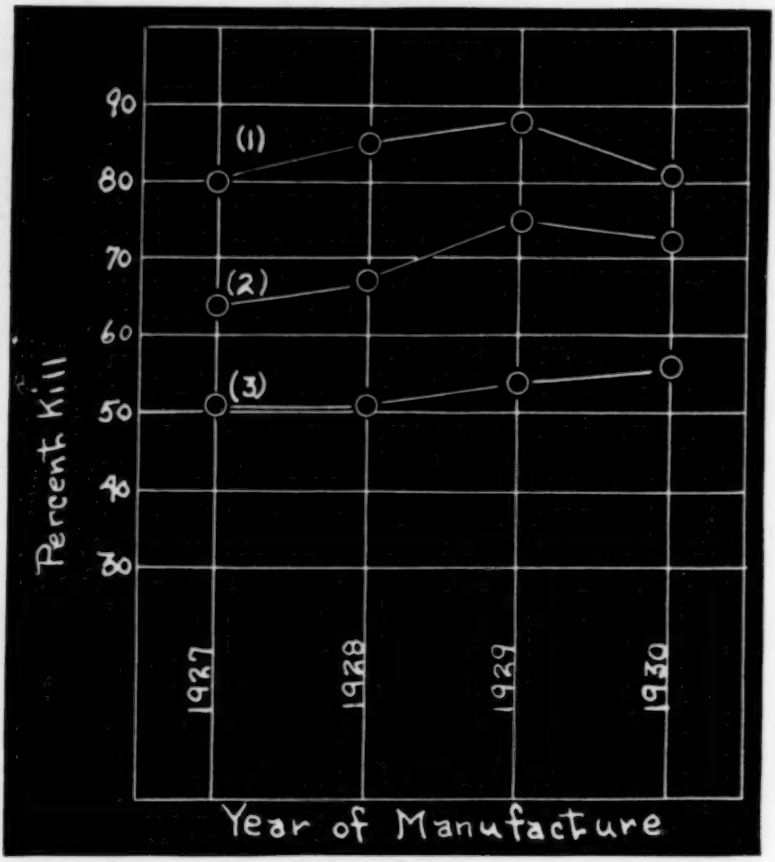


FIG. 16.—Showing the relative toxicity of samples of "Red Arrow" manufactured in the years 1927, 1928, 1929 and 1930 respectively. Tested. October, 1930.

Curve No. 1; Tested on honey bees (*Apis mellifera*). "Red Arrow" was used at a constant dilution of 1–4000, with water containing 0.1% soap.

Curve No. 2; Tested on *Aphis rumicis*. "Red Arrow" was used at the rate of 1–1000, diluted with water containing no soap.

Curve No. 3; Tested on *Aphis rumicis*. "Red Arrow" was used at the rate of 1–2000, diluted with water containing no soap.

The third section is concerned with a test of "Red Arrow" 1 to 2000 on the black bean plant louse (*Aphis rumicis* Linn.) and shows no diminution in toxicity. These general conclusions are illustrated in Figure 16.

Conclusions

By conditioning the final spray solution of "Red Arrow" to a point where it may be expected to penetrate the breathing system of insects and come in contact with the soft internal tissues, the toxicity of the pyrethrum charge may be multiplied by 3.6.

Storage of pyrethrins in a concentration of soap over a period of more than three full years does not seem at all materially to decrease the toxicity of the product.

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COMPARATIVE PERFORMANCE OF NICOTINE TANNATE AND LEAD ARSENATF AGAINST THE CODLING MOTH[1]

By Robert S. Filmer, *Associate Entomologist, New Jersey Agricultural Experiment Station*

Abstract

The increased activity of the Federal and State Pure Food Commission in regards to spray residue on fruit has made the question of arsenical substitutes of vital importance. Results of the past season's field tests with nicotine tannate are given in this paper.

The production of high quality fruit in the two-brood codling moth infested areas of New Jersey formerly called for extremely heavy applications of lead arsenate well up until picking time. With the establishment of spray residue requirements many orchardists were faced with the problem of washing fruit or modifying their spray schedules so that fruit could be placed on the market well under the residue requirements. Many orchardists found that this measure could be met at that time by modifying their spray schedules so that their heavy applications of lead

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology

arsenate were applied before the middle of July. Investigation by McLean (1) of the New Jersey Agricultural Experiment Station gave dates when final spray applications could be applied with safety and the harvested fruit still pass the domestic requirements. The further reduction of the domestic residue requirements in 1930 to .015 gm. of A_2O_3 per pound of fruit called for further judgment on the part of the grower. The grower was faced with the problem of further reducing his spray schedule in the face of increasing codling moth injury or to continue with an adequate spray schedule and wash his fruit in order to pass the domestic requirements.

As many orchardists at the present time have not been able to see their way clear to purchase expensive washing machinery there is an urgent need for an efficient arsenical substitute. Such a substitute need not replace lead arsenate entirely but should be of such a nature, and have such properties, that it could be safely applied to lead arsenate coated foliage. Such a substitute should replace the later lead arsenate sprays with as great a reduction in codling moth injury and at the same time do away with the necessity of washing fruit to have it pass the residue requirements.

For several years investigations have been undertaken by Headlee et al (2) at the New Jersey Agricultural Experiment Station in an effort to obtain a satisfactory substitute for lead arsenate to control the codling moth and other insects in general. Laboratory tests and field tests in 1929 with nicotine tannate against codling moth showed sufficient promise to warrant testing this material in a more thorough manner during the summer of 1930.

Tests in 1929 had shown that nicotine tannate was effective as a stomach poison against the codling moth when a continuous and thorough coating was maintained upon the fruit and foliage by frequent spray applications. The experiments in 1929 also showed that there was a rapid disappearance of nicotine tannate from the foliage so there was little danger of an objectional residue from frequent applications. The experiments were continued in 1930 in an effort to check the results obtained in 1929 with tank mixed nicotine tannate against second brood codling moth, and to test a powdered form of nicotine tannate that had been developed during the past year. As experiments in 1929 showed a rather rapid disappearance of nicotine tannate from the fruit and foliage it was planned to make spray applications at 10 day intervals in order to be reasonably sure there was a coating of the material on the fruit at all times.

PROCEDURE. The plan of experiments for 1930 called for the following experiments with tank mixed nicotine tannate.

1. Test on early fruit from 7 day spray onward.
2. Tests on late fruit from 7 day spray onward.

3 and 4. Comparison tests with tank mixed nicotine tannate and powdered nicotine tannate on late fruit. Nicotine tannate to be used against the second brood codling moth following first brood treatment with standard arsenate treatment.

The experimental blocks were selected in two commercial orchards in South Jersey, both of which showed considerable codling moth infestation. The orchard where tests 1, 3 and 4 were conducted showed much heavier codling moth infestation than the orchard where test No. 2 was run. In both cases the codling moth infestations were building up due to the modified spray schedules of the past few years.

The nicotine tannate used in these experiments consisted of two forms, the tank mixed nicotine tannate being mixed in the spray tank by combination of two pounds of C. P. tannic acid and 1 pint of "Black Leaf 50" to 100 gallons of spray material. The powdered form of nicotine tannate contained approximately 20% nicotine and was applied at the rate of 2 pounds to the 100 gallons. Both forms of nicotine tannate were applied with 2 pounds of skim milk as a spreader and 5 pounds of Koppers colloidal sulphur as a fungicide.

The experiment blocks in each test were selected to contain three rows of trees with from 13 to 20 trees in a row. The check plots which received the standard lead arsenate treatments were located on either side of experimental blocks. The counts on picked fruit were in all cases made from the center row trees.

BLOCK No. 1. The block selected for this test was adjacent to farm buildings and packing sheds in the Delair orchards at Moorestown, N. J. Trees in this block consisted mostly of Star variety with a few scattered trees of Delicious and Grimes varieties. Trees in this block received tank mixed nicotine tannate plus skim milk and flotation sulphur. The first spray was applied on May 29th with 3 following sprays at 10 day intervals and the apples picked the third week in July. Counts were made by selecting at random 100 apples per tree from a number of trees in the center rows of spray and check blocks. The check blocks in this test received 4 arsenical sprays. Results of counts are found in Table 1.

TABLE 1
Block No. 1

Spray	Variety	No. Apples	No. Clean	No. Wormy	% Wormy
Tank mixed nicotine tannate	Starr	900	801	99	11
Check, lead arsenate	Starr	700	625	75	10.7

BLOCKS No. 3 AND No. 4 are comparison blocks of tank mixed nicotine tannate and powdered nicotine tannate applied to late fruit. These blocks received nicotine tannate sprays for the second brood codling moth only. The first brood sprays consisted of standard lead arsenate treatments which consisted of 4 complete arsenical sprays. Counts made of per cent of codling moth injured apples made just prior to first application of nicotine tannate gave results shown in Table 2.

TABLE 2. PER CENT CODLING MOTH INJURY TO FRUIT AT TIME FIRST NICOTINE TANNATE SPRAY WAS APPLIED

Variety	No. of Apples Counted	Block No. 3	Block No. 4	Check
Wealthy	700	7%	9%	11%
Stayman	700	14%	12%	16%
Ben Davis	700	9%	11%	14%

BLOCKS No. 3 AND No. 4 received 6 additional sprays of nicotine tannate, the first spray being applied July 11th. The check block received one additional spray of lead arsenate the week following July 11th. Counts made at the time of harvest showed the following results.

TABLE 3. PER CENT OF INJURED FRUIT AT TIME OF HARVESTING

Variety	No. of Apples Counted	Block No. 3 Tank Mixed Nicotine Tannate	Block No. 4 Powdered Nicotine	Check Lead Arsenate
Wealthy	700	8%	11%	16%
Staymen	700	29%	43%	57%
Ben Davis	700	21%	37%	38%

BLOCK No. 2 consisted of tests with tank mixed nicotine tannate on late fruit from the 7 day spray onward. These blocks were located in a commercial orchard at Glassboro, N. J., and consisted of 39 trees of Ben Davis and Winesap varieties. Check plots 3 rows wide were located on either side. The check plot trees received the regular lead arsenate sprays that were applied to the remainder of the orchard, which consisted of five sprays of lead arsenate 4 to 100 with spreader and fungicide. The last spray was applied the week of July 16th.

The nicotine tannate block received tank mixed nicotine tannate plus skim milk and flotation sulphur at 10 day intervals from the seven day spray throughout the period of entry by the first brood and from the first cover spray for second brood and throughout the period of entry by that brood. This block received 10 nicotine tannate sprays. Counts were made by selecting 3 representative trees in the center rows of each block and making counts of all apples on the tree. Results of counts are shown in Table 4.

TABLE 4. APPLE COUNTS AT TIME OF HARVEST ON BLOCK NO. 2

Variety	Treatment	No. of Apples Counted	Per Cent Codling Moth Injury		
			Deep	Shallow	Total
Ben Davis	Nicotine Tannate	4700	7.3	10.4	17.7
Ben Davis	Lead Arsenate	5920	16.2	30.	36.2
Winesap	Nicotine Tannate	3885	9.2	12.4	21.6
Winesap	Lead Arsenate	3458	4.9	33	37.9

DISCUSSION. The results of experiments on early fruit (Table 1) show the same percentage control for plots receiving four applications of nicotine tannate as the check plots which received four applications of lead arsenate. The final sprays were applied the first week in July just prior to cessation of first brood codling moth activity and the fruit picked about the time second brood activity was starting. The residue on check plots which received arsenate at the termination of first brood activity was sufficient to protect the fruit for a considerable period, while only traces of nicotine tannate remained upon the fruit in the test plots. If codling moth activity had been prevalent during the three weeks previous to picking, at least one if not two additional nicotine tannate sprays would have been necessary due to the rapid disappearance of nicotine tannate from the fruit and foliage. Observations thruout the experiment showed no evidence of injury to fruit or foliage due to nicotine tannate.

Examination of the data in Table 3 which gives the results of experiments comparing tank mixed and powdered nicotine tannate show a rather decided advantage in favor of tank mixed nicotine tannate. This advantage is no doubt explained when we consider the great difference in physical properties of the tank mixed and powdered forms. When nicotine tannate is prepared in the spray tank a milky white suspension results in which the particles of nicotine tannate approach a colloidal form. Upon standing this suspension forms a loose watery mass which is readily suspended again with slight agitation. The powdered form of nicotine tannate was ground to pass thru a 300 mesh screen and formed a suspension which settled rather rapidly into a rather compact mass which was brought back into suspension again only with considerable agitation.

Analysis of the nicotine on the foliage before and after spray applications showed that considerably more of the tank mixed form was deposited upon the foliage and that a greater amount remained on the foliage between spray applications. In both forms however there was a very rapid disappearance of nicotine from the foliage, as much as 60 to 70 per cent being lost in 10 days. Observation thruout this experiment

showed no evidence of any foliage injury although nicotine tannate was applied to foliage heavily coated with lead arsenate.

A comparison of tank mixed nicotine tannate treated fruit with the check fruit shows a decided advantage in clean fruit in favor of nicotine tannate. However, we must not overlook the fact that the nicotine tannate treated blocks received six spray applications while the check plots received only one application of lead arsenate for second brood codling moth control.

Results of Table 4 where late fruit received ten applications of nicotine tannate between the 7 day spray and the time of harvest shows an increase in control for nicotine tannate over the check plots which received five applications of lead arsenate. Here again there is a decided advantage in clean fruit in favor of the nicotine treated blocks.

In summarizing, it is extremely difficult to draw definite conclusions from experiments which are so unevenly matched as the experimental and check plots have been in regards to the number of spray applications that each received. However, the writer feels that the effectiveness of nicotine tannate as a stomach poison in controlling the codling moth has been definitely established by the past season's work. It is to be admitted that the increase in codling moth control obtained with nicotine tannate, has been accomplished at the expense of more frequent spray applications. Whether this increase in spray applications is justifiable can only be determined by balancing this factor against the gain in clean fruit.

In passing it seems opportune to state that nicotine tannate possesses many of the properties desirable for a satisfactory arsenical substitute. However, at the present time there is need for further study to improve its adhesive qualities before nicotine tannate can be classed as an efficient arsenical substitute.

Conclusions

1. When a sufficient coating of nicotine tannate is maintained upon the foliage during the period of codling moth activity, nicotine tannate controls the codling moth as well as lead arsenate.

2. Nicotine tannate in the concentrations used does not injure either fruit or foliage.

3. Nicotine tannate in its present form rapidly disappears from the foliage, losses of 60 to 70% occurring in the 10 day period following spray applications. Before nicotine tannate can be classed as an efficient

arsenical substitute its adhesive qualities must be improved so that its effective period will be at least double its present effective period.

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WHAT SUMMER OIL SPRAYS MAY DO TO APPLE TREES[1]

By JOSEPH M. GINSBURG, Ph.D., *Biochemist in Entomology, New Jersey Agricultural Experiment Station*

ABSTRACT

Results of summer oil spraying during the last three years on large blocks of apple trees have shown that continuous application of oil emulsions during the growing season may bring about physiological changes in growth processes and fruit production. More injury to foliage resulted from early sprays, applied during May and June, than from late sprays, applied during July and August. Of the various vegetable and animal oils tested, Sperm Oil proved to be the least injurious to apple and peach foliage.

The insecticidal value of "saturated" petroleum oils as summer sprays on fruit trees is becoming more recognized by fruit growers from year to year. While originally introduced in the citrus growing region against scale insects, their application as contact poison and ovicide as well as vehicle for arsenical substitutes such as pyrethrum, nicotine, rotenone, etc., is now attracting wide attention of entomologists and chemists thruout the states. Already several commercial concerns are attempting to develop, by their usual advertising campaigns, a demand by the orchardist for summer oil emulsions. This is done in spite of the fact that our knowledge concerning the residual or cumulative effects of oil sprays on the growth and vigor of fruit trees is rather meager at present. The purpose of this paper is to present some data from experimental and commercial orchards on the effect of highly refined petroleum oil sprays on fruit trees.

EXPERIMENTAL. During the growing seasons of 1926 and 1927 various oils (2, 3) have been tested on peach and apple foliage with the result that sperm oil (which is primarily a liquid wax) from the group of vegetable and animal oils, and highly "saturated" medicinal petroleum oils of viscosities ranging from 160 to 320 Saybolt /100 proved the least

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

injurious to peach and apple foliage. The concentrations of oil tested ranged from 0.5% to 3%, using either soft soap or powdered skim milk as emulsifiers. The tests were carried out on young trees in the college orchard, sprayed from a bucket pump.

In the early part of the 1928 season it was decided to test out Nujol (a highly refined petroleum oil of 220 viscosity) on a large scale. For this purpose, four large blocks of apple trees, located in Collin's Orchard, Moorestown were sprayed once with 1% Nujol emulsified by the aid of skim milk and twice successively with 0.5% Nujol. The first spray was applied June 5th, and the two subsequent sprays were applied June 15th, and July 16th, respectively. The Nujol used for these sprays contained a kerosene extract of pyrethrum equivalent to about 1 pound of flowers to 1 gallon of oil. The pyrethrum extract was incorporated with the purpose of controlling codling moth larvae. One week after the first spray was applied, the young leaves began to show yellow areas which later resulted in appreciable leaf drop and a much heavier drop of fruit than on the check blocks, which received standard arsenical sprays.

Several factors suggested themselves as possible causes of this injury, such as the kerosene present in the Nujol, sulfur remaining on the leaves from previous sprays, sulfur remaining in the spray tank. In order to clarify these points several bearing apple trees of the Gravenstein variety were selected on the college orchard and sprayed with oil emulsions containing 0.5% sperm oil, 0.5%, and 1% Nujol. The Nujol contained the same amount of pyrethrum extract as used in the large blocks. Both oils were emulsified with powdered skim milk. The first spray was applied on July 12th and was repeated on July 24th, August 8th, and August 24th. The spray tank was thoroughly freed from sulfur and other residue before spraying.

Frequent observations of fruit and foliage did not disclose any injury, neither was there any drop of foliage or fruit in excess of that noticed on the standard blocks. On the other hand, the color of the leaves on the sprayed trees began to assume an increasingly darker green color after the second oil application than did the leaves on the unsprayed trees. This was especially noticeable on the trees which received 1% oil. It was also noticed that leaves remained attached to twigs in the fall until a later date in the season than on the checks. Later, chemical analyses have shown the oil sprayed leaves (4) contained about 28% more chlorophyll than was found in the check leaves.

Nothing unusual had been noticed in the growth of the trees the following spring. In order to study the possible cumulative effects

the experiments were repeated during 1929 with the exception that one Gravenstein tree was also sprayed with 0.5% Nujol containing 4% copper oleate. This tree had been sprayed during the previous year with 0.5% "Primol Heavy," a highly refined petroleum oil of 320 viscosity. Each tree received a total of eight sprays. The first spray was applied May 15th and the last spray was applied on the twentieth day of August.

The composition of the spray mixtures is given in Table 1. The trees were sprayed from a 200 gallon tank outfit capable of developing 300 pounds pressure to the square inch. Especial care was taken to thoroughly cover the trees from both, upper and under surfaces. The check tree did not receive any other sprays than a delayed dormant consisting of oil emulsion and cresylic acid, and one cover spray consisting of standard arsenical spray.

TABLE 1. COMPOSITION OF SUMMER OIL SPRAYS APPLIED ON APPLE TREES IN THE COLLEGE ORCHARD

	Ingredients Used	No. of Sprays	Foliage Injury
1.	Nujol 0.5% Pyrethrin—1 lb. flowers to 1 gallon Skim milk emulsifier	8	None
2.	Nujol 1% Pyrethrin—1 lb. flowers to 1 gallon Skim milk emulsifier	8	None
3.	Nujol 0.5% Pyrethrin—1 lb. flowers to 1 gallon Copper Oleate 4% Skim milk emulsifier	8	None
4.	Sperm Oil 0.5% Pyrethrin—1 lb. flowers to 1 gallon Skim milk emulsifier	8	None

No distinct injury to foliage from any one of the four different sprays has been observed. After the third application the foliage on the oil sprayed trees, as in the previous season, began to assume a darker green color than the unsprayed tree. This phenomenon was more noticeable on the tree receiving Nujol than on the tree sprayed with sperm oil. The green color was especially intense in leaves of the Gravenstein sprayed with Nujol containing copper oleate. Towards the end of the season the leaves sprayed with Nujol were deficient in pubescence and became somewhat brittle to the touch. This suggested a solvent action of the oil on the leaf waxes. In general, the appearance of the oil sprayed foliage closely resembled that observed in the previous year from similar oil treatments. Toward the end of the growing season the oiled trees appeared more vegetative and the leaves hung on to the twigs considerably longer in the fall than on the check tree.

OBSERVATIONS IN 1930. In the early spring of 1930 distinct differences appeared in the oil treated trees. The oil treated trees issued approximately three times as many blossoms than the check tree but very few leaves as may be seen from photographs in Plate 9. The lack of early foliage was pronounced most on the tree sprayed with 1% Nujol and least on the tree which received sperm oil. Also the blossoms opened up several days earlier on the oiled trees than on the check tree. It is regrettable that the tree sprayed with 0.5% Nujol alone had been removed prior to these observations due to road construction in the orchard and no data are available on its performance.

In view of this interesting development the oil sprays were abandoned and all the trees, check included, were given a standard arsenical spray during 1930. This was done in order to study the cumulative effects on the growth of trees from the previous two year sprayings.

Each of the oiled trees produced an abnormally heavy crop of apples, more than the tree could support. This resulted in a large drop of fruit during the last week of July and the first week of August. The apples were also considerably smaller and ripened about ten days earlier than on the check tree. Photographs of the trees taken at the time of picking are given in Plate 10. The baskets of apples along-side the trees indicate the number of apples that had dropped before picking. It must be noted here that this heavy drop was mainly due to over ripening, since about 80% of the apples picked from the ground were free from insect injury and fungous diseases.

Marked differences were also observed in the new growth of the trees as may be seen from the photographs. Retardation in new growth due to the oil treatment took place. This is especially noticeable in the tree sprayed with 1% Nujol. Of course, it must be borne in mind that the trees had been sprayed rather heavily during the two previous years which would probably correspond to extreme conditions not always encountered in commercial orchards. Nevertheless, it is demonstrative of the possible injurious effects of petroleum oils on tree growth.

RESULTS FROM TWO YEARS SPRAYING WITH OIL IN COMMERCIAL ORCHARDS. In 1929 a block of 45 trees of Winter Banana variety in the orchard of Robert Allen, Glassboro were sprayed with 0.5% Nujol emulsified with powdered skim milk. Kerosene extract of pyrethrum was incorporated in the Nujol equivalent to 0.75 pounds of flowers to one gallon of oil. A total of 8 sprays were applied during the period between May 31st and the 20th of August. The material was applied with a bean cluster nozzle, with the exception of 4 trees on which a spray gun was

used. This experiment was conducted with the purpose of controlling codling moth, the results of which have already been presented elsewhere (6). No injury to foliage or fruit could be noticed until after the third spray. In the first week of July small brownish spots appeared on the foliage which were due partly to black rot injury, but primarily to the effect of oil. This injury has slightly increased in intensity with the succeeding five sprays, but no permanent damage resulted. No defoliation nor fruit drop, symptoms usually accompanying severe oil injury, occurred. Neither was there any marked difference in the fruit. The apples in the oil block ripened at the same time, possessed the same color and size as those in the check blocks which received standard arsenical sprays. The oil trees in general, however, showed more vegetative growth at the end of the summer. Also the setting of fruit the following spring was smaller than in the standard blocks.

In order to study the cumulative effects of oil sprays the experiment was repeated on the same block of trees during 1930. The trees received a total of 9 sprays, the first spray on May 23rd and the last on August 28th. The only difference in the composition of the spray of 1930 from that of 1929 was that 4% copper oleate had been incorporated in the Nujol before it was emulsified. This was done with the purpose of studying the effect of this chemical on foliage when combined with oil, since it was thought that it may possess fungicidal value and could possibly be used as a substitute for sulfur fungicide in oil sprays.

As in the previous year, injury was first noticed on June 24 or about one week after the third spray. The injury, however, did not advance beyond yellowish to brown spots in the foliage and no defoliation or fruit drop resulted. At the time of picking (September 8) the apples from the oil block were slightly smaller than in the standard block and retained a heavy coat of dust on their surface which gave them a dirty green appearance. The average number of apples per bushel basket was 213 and 191 from trees in the oil and standard blocks respectively.

Simultaneously with the above experiment four other blocks of apple trees located in Lester Collins' orchard in Moorestown have been sprayed with oil. Three blocks, consisting of early varieties, such as Grimes, Delicious, and Stars, received only four early sprays. The first spray was applied on May 29, and the last spray on July 3. One block received 0.5% Nujol containing pyrethrum as in the previous orchard; another block received 0.5% "Marcol" (white oil of about 80 viscosity) containing pyrethrum; the third block received 0.5% Marcol containing rotenone. No injury to foliage or fruit had been noticed on any one of the above varieties.

The fourth block of apple trees consisted of late varieties such as Wealthy, Stamen, and Ben Davis. These trees received six sprays of 0.5% Nujol, containing pyrethrum, at approximately ten-day intervals, between July 14 and September 7. Prior to the oil sprays this block had received several arsenical sprays. This procedure was adopted in order to control the second brood codling moth with the elimination of arsenical residue.

Again, as in the previous three blocks, no oil injury was observed. Whether the varieties included in these blocks are less susceptible to the effects of oil than is the Winter Banana variety or whether the variables in climatic factors and soil conditions encountered in these two localities (which are approximately 30 miles apart) are responsible for the differences secured, it is hard to state.

Discussion. A comparison of the results presented in this paper clearly indicates that "saturated" petroleum oils when applied on foliage of apple trees for insect control may bring about physiological changes in growth processes and fruit production of the plant. Whether or not these disturbances are beneficial or detrimental to the life of the tree remains to be seen from more prolonged studies of their cumulative effects.

The physiological reaction of the plant to petroleum oils is variable, depending on the properties of the oil; the concentration of the oil in the spray; nature of plant; condition of the tree; and climatic factors. Investigations with summer oil sprays in New Jersey, conducted during the last four years, have brought out some valuable information concerning the influence of these oils on fruit trees. From these results and those of other investigators (1) we learn that petroleum oils can not be sprayed even in the minimum concentration (about 0.5%) necessary for insect control, without injury to the growing plant unless they have been highly refined, that is completely freed from unsaturated hydrocarbons. Moreover, even when completely saturated the danger of foliage injury is not entirely eliminated.

It may be definitely stated, from the results obtained, that oil applied on apple trees during the months of May and June, when the leaf tissue is soft and is growing rapidly, is apt to cause distinct and often severe injury, resulting in partial defoliation and fruit drop. On the other hand, the same oil applied during July and August when new growth of foliage is slow and the leaf-tissue and the new wood have comparatively hardened, may cause no injury. These observations are not applicable to all kinds of trees. Peach trees, for instance, can stand a higher

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A row of apple trees showing differences in blossoms and leaf growth.
(1) Check tree; (2) Sprayed with 0.5% Sperm Oil; (3) Sprayed with 0.5% Nujol containing 4% Copper Oleate.

A row of apple trees at picking time. The baskets of apples along side the trees indicate the amount of drop of ripe fruit. (1) Check tree: (2) Sprayed with 0.5% Sperm Oil; (3) Sprayed with 0.5% Nujol containing Copper Oleate.

dosage of oil (1%) in the early part of the season and much more (2% to 3%) in the later part of the season than can apples. The difference in susceptibility of various trees to oil injury may be correlated with the rate of penetration of oil into leaf tissue. Generally, petroleum oils penetrate leaf tissue (5) very rapidly thru the under surfaces, primarily where the stomata are located, and only slowly thru the upper surfaces of apple and peach foliage. Drops of oil applied on apple leaves remained on the upper surface for several days, but penetrated thru the under surface within one or two hours. While all petroleum oils, of flowing consistancy at room temperature, will penetrate stomata of growing leaves, the rate of penetration is inversely proportional to the viscosity of the oil (5).

Altho the mechanism responsible for oil injury is not altogether clear, it may be said with certainty, from field and laboratory observations, that soon after the oil has penetrated into the leaf, the tissue becomes translucent, turns brown, and eventually dies. The rapidity with which the injury develops varies with the kind of oil, species of plant, climatic factors, etc. The oil, once it has penetrated into the leaf tissue may produce injury or abnormalities in the plant by interfering with transpiration and respiratory activities as suggested by Kelley (8, 9). The oil may also exert some solvent action on the waxy materials present on or in the cuticle of leaves, thereby allowing undue evaporation of water to take place.

Studies during the last year on light absorption by refined petroleum oils have eliminated the possibility that a thin coat of oil on the leaf surface, such as is deposited by spraying, may absorb and hold some of the sun rays necessary for photosynthetic activities and which would have otherwise reached the chloroplasts of the green leaf. The results of these studies will be published at a later date.

That summer oil sprays, applied judiciously, may serve as an arsenical substitute, either directly or as a vehicle for pyrethrum, nicotine, rotenone or similar insecticides, against codling moth and other insects has been shown by the work of Dr. Headlee (6) and others (7, 10). Injury, however, often accompanying these sprays, strongly suggests that, until we learn more about its cumulative effects on growth of trees and how to control or eliminate them, it may prove an unsafe weapon in the hands of the orchardist, and farmer in general.

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Summary and Conclusions

Several highly refined petroleum oils ranging in viscosities from 80 to 320 Saybolt /100 and sperm oil have been sprayed on apple and peach trees during the spring and summer months. The oils were emulsified with either soap or powdered skim milk and applied in concentrations of from 0.5% to 3% actual oil. Several blocks of apple trees were sprayed continuously during two successive seasons and the cumulative effects of the oil on foliage and fruit were studied. The results presented in this paper suggest the following conclusions:

1. Peach trees are less susceptible to oil injury than apple trees.
2. Continuous oil spraying of apple trees during the growing season may bring about physiological changes in growth processes and fruit production.
3. Oil injury is more pronounced and is of a severer nature from early sprays applied during May and June than from late sprays applied during July and August.
4. Sperm Oil proved less injurious to peach and apple foliage than anyone of the animal and vegetable oils tested.

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Friday Afternoon, November 21, 1930

PERFORMANCE OF THE THERMAL CONSTANT AS AN INDICATOR OF THE TIME TO APPLY COVER SPRAYS FOR CODLING MOTH[1]

By THOMAS J. HEADLEE, Ph.D., *Entomologist, New Jersey Agricultural Experiment Stations*

ABSTRACT

Through a period of three years, 1928, 1929 and 1930, the thermal constant has been used for practical determination of the time when cover spraying should start for the first and for the second broods of codling moth and has seemed to be eminently successful for that purpose. It seems likely that the thermal constant can be used as a satisfactory practical determinator of the length of periods during which spray coatings must be maintained on fruit and foliage against entry by larvae of the first and of the second broods. When the average weekly minimum temperatures reach about 60° F pupation of summer larvae seems to cease and it is thought that these minimum temperatures are probably the agency limiting the number of codling moth broods.

In 1928 the writer (3) presented evidence to show that the thermal constant had possibilities as a determinator of the time to apply cover sprays for the codling moth. By the term "cover sprays" is meant the application of insecticides, usually arsenicals, in such a manner as to keep foliage and fruit of the apple tree film-coated during the periods of fruit entry by codling moth larvae of the first and of the second generations. The thermal constant has been used for the past three years, 1928, 1929 and 1930, as a means of determining when cover spraying should start for the first brood and also when it should start for the second brood. The primary purpose of this paper is to show how the theoretic dates derived from the thermal constant compare with the actual dates as determined from codling moth emergence cages and the secondary purpose is to show how the thermal constant indicator compares with the actual determination of the time when spraying may cease for the first and second broods, respectively.

In the paper, above referred to, it was pointed out that there seems to exist a correlation between the average weekly minimum temperatures of the summer season and the ceasing of pupation, thereby setting a limit to the number of broods. It is, also, the purpose of this paper to set forth additional data bearing upon this question.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

PERFORMANCE OF THE THERMAL CONSTANT. The primary portion of this study of the performance of the thermal constant was made at Glassboro, New Jersey in the two-brooded section of the state. This study has furnished data for four years, 1927, 1928, 1929 and 1930, and the general results are set forth in Table 1.

TABLE 1

Data Titles		Place and Date Glassboro			
		1927	1928	1929	1930
Date of beginning first cover spray for first brood	Theoretic	6/5	6/4	5/26	5/17
	Actual	6/6	6/5	5/27	5/21
	Variation from actual	1 day	1 day	1 day	4 days
Date of beginning larval entry		6/17	6/14	5/31	5/29
Length of period between first cover spray and first larval entry		12 days	10 days	5 days	12 days
Date when emergence of first brood ceases	Theoretic	6/25	6/27	6/27	6/13
	Actual	7/1	6/29	6/21	6/20
	Variation from actual	6 days	2 days	6 days	7 days
Date when larval entry ceases		7/18	7/13	7/8	7/6
Length of entry period for first brood larvae		31 days	29 days	38 days	38 days
Date of beginning first cover spray for second brood	Theoretic	7/23	7/22	7/16	7/12
	Actual	7/26	7/25	7/21	7/21
	Variation from actual	3 days	3 days	5 days	9 days
Date of beginning larval entry		7/29	7/27	7/19	7/18
Length of period between first cover spray and first second brood larval entry		6 days	5 days	3 days	6 days
Date when emergence of second brood ceases	Theoretic	9/5	8/29	8/24	9/13
	Actual	9/9	8/31	8/27	9/15
	Variation from actual	4 days	2 days	3 days	2 days
Date when larval entry ceases		9/15	9/9	9/5	9/15
Length of entry period for second brood larvae		48 days	44 days	48 days	59 days

The date of beginning the first cover spray for first brood may be defined as the date on which one-half of the first brood of moths has emerged. The date of beginning the first cover spray for the second brood may be defined as the date one week before one-half of the second brood of moths has emerged.

This table shows that while there exists considerable variation in the theoretic dates for the different years considered, the variation between the theoretic and actual date is small. For the years 1927, 1928 and 1929 the difference is one day and for the year 1930 the difference is four days.

The next point of importance in this table is the time which elapses between the theoretic date of the beginning of the first cover spray and the actual beginning of larval entry into fruit. This seems to be for 1927 twelve days, for 1928 ten days, for 1929 five days, and for 1930 twelve days. This period is ample to complete the application of the first cover spray which should not in any case require more than one week.

The next point of importance is the relationship of the theoretic date when emergence of first brood ceases to the actual date when this occurs. This is found to be in 1927 six days, in 1928 two days, in 1929 six days, and in 1930 seven days.

The next point of importance in this table is the date when larval entry ceases and consequently the number of days during which larvae of the first brood have been engaged in entering the fruit. In 1927 this period was thirty-one days, in 1928 twenty-nine days, in 1929 thirty-eight days, and in 1930 thirty-eight days. The period of entry is thus seen to cover approximately a period of four to five weeks and normally in New Jersey would require from two to three sprays depending upon the rainfall to maintain the spray coating throughout the period.

The next point of importance is the variation between the theoretic date of beginning the first cover spray for second brood and the actual date. This difference is seen to be in 1927 three days, in 1928 three days, in 1929 five days, and in 1930 nine days.

The next point of importance is the date of beginning of second brood larval entry into fruit and the length of period existing between the theoretic date of beginning of first cover spray for second brood of codling moth and the start of larval entry. In 1927 this period was six days, in 1928 five days, in 1929 three days, and in 1930 six days. This period seems a little bit short for the orchardist to complete the application of his first cover spray for second brood before entry occurs but when we take into consideration the fact that there is still a considerable amount of residue on the fruit and foliage from spraying for the first brood, the period is probably not much too short. If we advance this date three days the period would be ample for all ordinary conditions because it is the aim of the New Jersey orchardist to complete spray application on his orchard within a period of one week from the time of starting.

The next point of interest in this table is the comparison of the theoretic and actual dates when emergence of the second brood of moths ceases. In 1927 the difference was four days, in 1928 two days, in 1929 three days and in 1930 two days.

The last point of importance in this table is the date when larval entry ceases and consequently the length of period during which larvae of the second brood are entering the fruit. This is seen to be in 1927 forty-eight days, in 1928 forty-four days, in 1929 forty-eight days and in 1930 fifty-nine days. This period ranges between six and eight weeks in length and would require for the maintenance of coating five or six cover sprays. The great bulk of codling moth injury is done by the second brood and the writer is certain that there has been too little strenuous effort to combat the work of the second brood. While it is true that the parents of the second brood belong to the first brood and that if the first brood is cut low enough the second brood will not amount to much, it is also true that under conditions of heavy infestation the percentage of first brood larvae that succeed in reaching maturity, while very small, is sufficient to produce a dangerous second brood. It is the experience in New Jersey that if 1% of the total fruit borne by the trees is injured by the first brood the second brood is apt to be large enough to demand vigorous efforts against it.

TABLE 2

Average Weekly Minimum Temperatures at Glassboro

1927		1928		1929		1930
5/7 —46.8		5/5 —47.8		5/4 —44.5		5/3 —46.1
5/14—50.0		5/12—44.8		5/11—41.4		5/10—62.7
5/21—47.1		5/19—47.5		5/18—50.7		5/17—58.2
5/28—50.5		5/26—50.1		5/25—48.1		5/24—53.4
6/4 —48.0		6/2 —53.5		6/1 —61.7		5/31—45.7
6/11—56.2		6/9 —57.2		6/8 —48.7		6/7 —56.7
6/18—51.1		6/16—57.8		6/15—56.7		6/14—60.4
6/25—58.8		6/23—57.8		6/22—64.7		6/21—65.0
7/2 —56.7		6/30—66.1		6/29—66.5		6/28—63.0
7/9 —57.4		7/7 —64.8		7/6 —61.1		7/5 —63.5
7/16—50.8		7/14—68.2		7/13—68.5		7/12—62.8
7/23—66.0		7/21—68.8		7/20—58.2		7/19—62.5
7/30—68.5		7/28—70.1		7/27—62.2		7/26—70.2
8/6 —62.4		8/4 —65.7		8/3 —66.7		8/2 —68.2
8/12 8/13—61.4		8/11—71.2		8/10—61.2		8/9 —71.7
			8/13			
8/20—58.2	8/18	8/18—61.0		8/17—63.7		8/16—57.8
8/27—57.8		8/25—63.7		8/24—59.5	8/23	8/23—57.8
9/3 —60.4		9/1 —68.2		8/31—57.0		8/30—60.5
9/10—60.0		9/8 —57.7		9/7 —65.8		9/6 —62.5
9/17—58.7		9/15—61.0		9/14—65.1		9/13—60.8
9/24—53.2		9/22—58.8				9/20—64.7
		9/29—43.5				9/27—61.1

Note:—Line indicates pupation ceased.

The variation of dates determined by the thermal constant from dates determined by codling moth emergence cages is small enough

distinctly to indicate that the thermal constant has formed a satisfactory indicator during four successive years, 1927, 1928, 1929 and 1930, for the time of the beginning of the first cover sprays for first and second broods and for the periods during which the film coating must be maintained against larval entry by caterpillars of the first and of the second broods. Furthermore, the study of these dates and periods in relation to actual orchard determinations of larval entry into fruit show that they represent the facts as they exist under practical conditions in large orchard plantings.

Correlation of Summer Average Weekly Minimum Temperatures with the Ceasing of Codling Moth Pupation. The data secured from the study of the relation of minimum temperatures to the ceasing of codling moth summer pupation covers a period of four years, 1927, 1928, 1929 and 1930 and was accumulated at Glassboro, New Jersey, in the two-brooded area of the state. The results of the study at this point are set forth in Table 2.

This table shows that when the summer average weekly minimum temperatures reach the immediate neighborhood of 60° F pupation ceases. The correlation pointed out is obvious but the causes of the correlation are obscure.

From our three year studies of the thermal constant derived from data secured from eight or more field stations, covering the single-brooded, single plus partial second-brooded and full two-brooded areas, it is clear that this failure to pupate is not due to the lack of an accumulation of sufficient day degrees thought to be necessary to bring about this phenomenon. Furthermore, a study of the average weekly minimum temperatures for the months of May and June derived from these various field stations shows that during these months, particularly May and early June, the average weekly minimum temperatures are mostly 60°F or below, yet during May and June pupation of overwintering larvae takes place and moths emerge. Obviously, therefore, there exists no distinct correlation between average weekly minimum temperatures in May and June such as seems to exist in July and August. Furthermore, in the single-brooded areas of the state the average weekly minimum temperatures from early July on run about 60° F thus exhibiting again a correlation between the summer weekly minimum temperatures and the failure of the summer larvae to pupate.

So far as the data from New Jersey field stations go, it seems that wherever and whenever this summer average weekly minimum reaches about 60° F. or below no further pupation of summer larvae occurs. If

this temperature condition comes before there is a second brood there is no second brood. If it comes during the second brood there is only a partial second brood. If it comes at the end of the second brood period there is no third brood.

Thus we have eliminated the thermal constant as being concerned with the limiting of the number of broods and have indicated that the brood limiting factor appears to lie in summer minimum temperatures and that while these minimum temperatures are apparently powerful when they affect summer larvae they are ineffective when they are brought to bear upon overwintered larvae. It seems to the writer that this must mean that the chemical set-up of the overwintered larva is different from the chemical set-up of the summer larva.

Conclusions

1. The thermal constant appears to be a satisfactory practical indicator of the date on which the first cover spray should be applied for first brood and for second brood, respectively.

2. The thermal constant appears to be a satisfactory practical determinator of the length of periods during which spray coatings must be maintained on fruit and foliage against entry into fruit by larvae of the first and of the second broods, respectively.

3. The minimum temperatures of the summer season appear to be the factor limiting the number of broods which a locality may experience through the ceasing of pupation of larvae wherever and whenever the average weekly minimum temperature reaches about 60° F. or below.

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HINTS AT NEW SPRAY PROCEDURES

By P. J. PARROTT, F. Z. HARTZELL, HUGH GLASGOW, and S. W. HARMAN, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

The standard spray schedule provides for the control of the more important apple insects. It displays some weaknesses against certain species during seasons when weather conditions prevent timely applications. Investigations have been conducted to find materials or practices that will amplify present means of control of rosy aphids and bud moth. Three methods have been tested; viz., (1) autumn defoliation, (2) fall spraying, and (3) winter treatment. Sodium nitrate proved the best material for rendering the trees unattractive to the rosy aphid, and apparently is safe to the twigs. None of the defoliation materials controlled bud moth. Fall spraying with nicotine or ground tobacco killed the fall migrants and the egg-laying females of the rosy aphid, but the utility of this means of control remains to be determined. Winter treatment with tar distillate sprays were very effective against apple aphid eggs and the nymphs of the spruce gall aphid, but proved ineffective against the eggs of the leafroller. These washes appear to be safe to the trees. As regards rosy aphid, these methods of treatment, if successful, may prove of value in that the period of spraying could possibly be extended.

The apple spray schedule, based largely on the employment of lime-sulfur and lead arsenate, and providing for the use of nicotine in certain applications, affords a high degree of protection against the major pests. However, it displays some weaknesses, considered either from the standpoint of its utility against certain of the many insects that attack apple trees or from the standpoint of difficulties experienced by growers in carrying out needed specifications. Certain applications and materials do not always meet the actual requirements, considering the number and habits of the species that frequent an apple orchard. Moreover, there are growers who, despite repeated coaching and special instruction, seem unable to attain the skill necessary for the accomplishment of their aims with existing spray materials and methods.

Broadly speaking, the standard spray program meets the needs of most New York growers with respect to apple scab, San Jose scale, rosy aphid, codling moth, apple maggot, curculio, and red bug. Of the specific species that may be mentioned, the control of rosy aphids occupies an important place largely because the treatments must be very accurately timed when applied as a delayed dormant spray. In addition to the above widely prevalent pests, orchardists during some seasons and in certain localities, need also to control leafrollers, leafhoppers, and bud moth which, in individual instances, often attain a position of major importance. For these latter insects other provisions must sometimes be made, which usually demand extra treatments or

special materials, and if a high degree of control is secured this is usually obtained at large expense.

Knowledge of these conditions has stimulated a number of lines of effort at the Geneva Station to determine the vulnerability of certain pests to procedures that differ from conventional practices either with respect to materials employed or season of application. These may be enumerated as follows: (1) autumn defoliation, (2) fall spraying, and (3) winter treatments.

Autumn Defoliation of Apple Trees. This method of attack was planned especially for the control of bud moth and rosy aphids. During the early autumn of 1929, tests were made of the following: (1) sodium nitrate, 1 pound per gallon; (2) sodium arsenate, 1 pound in 20 gallons; (3) copper sulfate, 1 pound in 10 gallons; (4) salt, 1 pound per gallon; (5) sulfuric acid, 1 per cent; (6) lime-sulfur, 1 gallon in 10 gallons; and (7) bichloride of mercury, 1 ounce in 10 gallons of water. Sodium arsenite proved the best defoliator but injured the twigs. Sodium nitrate destroyed the leaves very effectively, and no injury to twigs has so far been detected. The other materials neither killed all the leaves entirely nor produced sufficient defoliation to be effective. Both sodium nitrate and sodium arsenite caused a marked reduction of aphids on the trees in 1930, but neither material was sufficiently effective on bud moth to be deemed a practical control of this insect. The data on rosy aphis is given in Table 1.

Fall Spraying. This investigation is being carried out under two phases; namely, when the fall migrants of the rosy aphid have become established on apple trees, and when egg-laying females have developed. The various mixtures tested contained either nicotine or ground tobacco as the killing agent. The investigation was started in the autumn of 1930 and while the susceptibility of certain insects, notably apple aphids, was strongly indicated, the actual utility of the system remains as yet to be determined.

Dormant Treatments. For a number of years lime-sulfur and petroleum oil sprays have been applied during the dormant period. The former, as is well known, is effective against San Jose scale, while the latter controls San Jose scale, red mite, and leafrollers. However, neither material when used against aphid eggs or hibernating bud moth larvae has given satisfactory protection.

English workers (1) have investigated coal tar oils with the aim of determining the fractions of greatest utility as insecticides and their effect on the health of trees. They claim that tar acids are undesirable con-

stituents of tar distillate sprays. They also assert that the most valuable elements of neutral tar oils, at least for certain insects, are contained in the fraction boiling between 280° and 360° C. after the anthracene, which settles out on cooling, has been removed. This modified fraction, emulsified by means of Agral WB (a proprietary material) and an alkali, constitutes the Long Ashton Tar Distillate Wash which is marketed as a two-solution spray material. This wash is made by several English commercial firms. Other tar distillate sprays which are claimed to be similar to or at least serve a similar purpose as the Long Ashton formula are made and sold under various proprietary names.

Tests of two English tar distillate washes were made on apple trees at Geneva, the sprays being applied during February, 1930. The materials were (1) a Long Ashton Tar Distillate Wash made by Solignum, Limited, and (2) "Ovicide" furnished by MacDougal and Sons. The dilutions used and the results on rosy aphids are shown in Table 1. It will be noted that very good control of aphids was secured. The red bug population during the past season, at least in the vicinity of Geneva, was very light so the results of the tar washes on the eggs of these insects are inconclusive. However, no injury by red bugs was present on the trees sprayed with these materials.

TABLE 1. RESULTS OF AUTUMN DEFOLIATION AND TAR DISTILLATE SPRAYS ON ROSY APHIS

Materials Used Amount per 100 Gallons of Spray	Time of Application	Total Apples per Tree	Aphid Apples per Tree	Apples Injured by Aphids Per Cent
Greening Orchard				
Sodium nitrate, 100 lbs.	Sept. 12, 1929	1430	49	3.4
Sodium arsenite, 5 lbs.	Sept. 13, 1929	496	2	0.5
Tar Distillate (Solignum Long Ashton Wash) 10 gallons	March 20, 1930	774	14	1.7
Tar Distillate (Ovicide) 12½ gals.	March 20, 1930	360	3	0.7
Check	———	1299	163	12.5
Rome Beauty Orchard				
Tar Distillate (Solignum Long Ashton Wash) 10 gallons	March 20, 1930	2227	2	0.07
Tar Distillate (Ovicide) 12½ gals.	March 20, 1930	2052	12	0.6
Tar Distillate (Creosote Oil) 10 gals.	March 20, 1930	1079	0	0
Check	———	1548	285	18.2

Laboratory tests on eggs of the green apple aphid were conducted with Ovicide. Twigs containing eggs were collected in the orchard and placed in an open insectary during the last week of March, 1930. On April 16 the twigs were divided into two lots, the first of which was treated and the second left as a check. In this test the tar distillate gave 100 per cent reduction.

English tar distillate washes were used on seventy-five Norway spruce trees for the control of the spruce gall aphid (*Adelges abietis*) in 1929 and 1930. During both years the sprays were applied the last week in April, which was just previous to the beginning of the growth period. The concentrations were one and three per cent in 1929 and one, three and five per cent in 1930. These treatments gave the following results: 1 per cent solution, 99.9 per cent reduction in galls in 1929 and 99.5 per cent reduction in 1930; 3 per cent, 100 per cent reduction both years; and 5 per cent gave 100 per cent reduction in 1930.

During both 1929 and 1930, trials of English tar distillate washes were made on eggs of leaf rollers. At the same time other egg masses were tagged and sprayed with lubricating oil emulsion. The egg masses were located and tagged on the trees before treatment, and the records were made several weeks after all viable eggs in the untreated masses had hatched. The results are shown in Table 2. It will be noted that the tar distillates did not give as efficient control of leafroller as did lubricating oil emulsion.

TABLE 2. EFFECT OF SPRAYS ON EGGS OF LEAF ROLLER

Material Amount per 100 Gallons Spray	Year	Number of Eggs in Test	Per Cent of Eggs Hatched
Tar Distillate Emulsion, 9 gallons	1929	840	63
Check	1929	1943	98
Tar Distillate (Ovicide) 12½ gallons	1930	320	73
Diamond Paraffin Oil, 8 gallons Bordeaux (2–2–100)	1930	1380	0
Check	1930	1150	100

At the present time the greatest disadvantage of the English tar distillate washes lies in their cost. In addition to tariff duties, part of this cost may be due to the extra refinement of the tar oils and part to the special emulsifier used. It seemed worth while to determine what insecticidal value American tar oils possess. Since the less refined by-products of gas and coke manufacture are relatively cheap, and because chemical studies of certain American tar products seem to indicate that there may be physical and chemical differences between European and American crude tar oils having the same range of boiling points, it was deemed best to start with a fraction boiling between 200° and 360° C. This fraction is a commercial commodity and is called Creosote Oil in the American trade. It appears that in European practice the term "creosote oil" is applied to the fraction distilling between 240° and 270° C., so care must be exercised not to confuse the two materials (2). As used in this article the American definition is meant. They should also be carefully distinguished from wood creosote.

Workers in Holland are credited with having developed a tar oil emulsion consisting of a fraction with boiling points similar to American creosote oil emulsified with resin fish oil soap. This emulsion is claimed to be effective against aphid eggs. The particular American creosote oil used in the Geneva investigations was manufactured by the Rochester Gas and Electric Company. The best emulsifiers proved to be sulfonated vegetable or animal oils with alkali. The alkalis tested in the laboratory were either sodium hydroxide, sodium carbonate, or sodium metasilicate [Na_2SiO_3], any of which seem satisfactory. In the orchard tests sodium hydroxide alone was used.

Among vegetable products, sulfonated castor oil made an excellent emulsifier, but is a rather expensive ingredient. Of animal substances, sulfonated cod oil is a commercial commodity and can be secured at about 75 cents per gallon in barrel quantities, which is considerably cheaper than sulfonated castor oil. The former was found to be an effective emulsifier of American creosote oil. It is interesting to note that crude Menhaden oil costs about three-fifths as much as crude cod oil. Menhaden oil was successfully sulfonated in the laboratory, and with alkali was found to emulsify creosote oil as readily as sulfonated cod oil and alkali. Unfortunately, so far there has been no demand for sulfonated Menhaden oil so at present it is not a commercial product. However, if there were a large demand it might prove to be one of the cheaper materials for emulsifying coal tar distillates.

As will be noted in Table 1, American creosote oil emulsion applied in February, 1930, proved very effective against rosy aphid eggs. For the reasons assigned above the tests against red bugs are inconclusive.

The chief disadvantage of American creosote oil is that definite standards have not been established with respect to its chemical and physical properties. Since it is claimed that materials from different sources vary somewhat in these respects, further investigation is necessary to set proper standards from the standpoint of entomological needs.

Conclusions

Autumn defoliation of apple trees, while failing to control bud moth, had a noticeable influence on rosy aphids. Of the materials tested, nitrate of soda (1 pound per gallon) seemed to make the trees unattractive to the insects, with no indication at present of injury to the trees.

Fall applications of nicotine or ground tobacco to apple trees, either when fall migrants or when egg-laying females were present on the trees, reduced to an important extent the number of apple aphids.

English tar distillate sprays appear to have been very effective against apple aphids and spruce gall aphid, but unfortunately the reduction of leaf roller was not marked. The utility of these washes on red bug was not demonstrated because of the small infestation of the treated trees. No injury to the trees was apparent.

Applications of American creosote oil emulsified with sulfonated castor oil and alkali killed the eggs of the rosy aphis and apparently caused no serious injury. The effect on red bug is undetermined because of the sparse population. Sulfonated fish oils with alkali emulsified creosote oil thus suggesting that the cost of the spray may be reduced.

As regards rosy aphis, if these various methods prove effective, they may offer a marked advantage over spring spraying alone, in that they make possible a longer period during which apple growers may conduct spray operations, even if the entire acreage cannot be completed with any single treatment or method. By using a combination greater latitude would be afforded owners of large plantings.

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SOME HABITS OF THE ADULTS OF THE ORIENTAL FRUIT MOTH WITH REFERENCE TO BAITS[1]

By S. W. FROST, *The Pennsylvania State College*

ABSTRACT

Habits of the adults of *Laspeyresia molesta* Busck are discussed, namely: (1) Moth population of a tree; (2) distribution of moths in an orchard determined by clipping infested terminals and by means of bait traps; (3) emergence and number of broods; (4) moth releases and their significence.

This paper is a continuation of the work conducted during 1929.[2] It emphasizes the fact that there is a decided need for further knowledge of the habits of the adults of the oriental fruit moth as well as those of the larvae and pupae.

MOTH POPULATION OF A TREE. The determination of the moth population of a tree at any given time during the summer is difficult.

[1]Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station as technical paper No. 514.

[2]Jl. Econ. Ent. 23: 813–821, 1930.

Bait traps do not give an accurate idea, for it is certain that they have attractive power and show a greater number of moths per tree than normally reside or hover in the tree. Counts of terminal injury provide the easiest and most accurate method of determining moth population, but have its difficulties because a single larva may inhabit several twigs. This method serves well when comparing two separate blocks of trees.

The actual moth population of a tree can be determined by dusting with a 4 per cent lime-nicotine dust preferably during the hottest part of the day. A large white sheet is placed beneath the tree to catch the moths that fall. On July 23, 1928, ten Elberta trees were dusted where baits, twig infestation and other conditions pointed to the highest infestation in the whole orchard. The results showed an average of one moth per tree. On August 8, 1928, dusting in the same part of the orchard revealed ten moths per tree.

Similar experiments conducted in a block of Krummels on July 23, 1930, showed one moth per tree, and in a block of Hale, one-half moth per tree. It is interesting to note that during the same week,—July 15th to July 23rd,—565 moths were taken from ten bait traps in the Krummel block, or 56.5 moths per pail per week, or 8.0 moths per pail per day. Further studies along this line are advisable, especially when dusting experiments can be continued on successive days to determine if trees are repopulated where baits are not used.

TABLE 2. SUMMARIES OF CATCHES FROM BAIT TRAPS; 1928, 1929, 1930 IN A PEACH ORCHARD NEAR ARENDTSVILLE, PA.

Variety	April	May	June	July	Aug.	Sept.	Oct.
				1928			
1 Hale*	—	197	14	605	296	14	—
3 Krummel*	—	61	3	112	17	27	227
7 Hiley	—	103	8	466	390	8	—
8 Carman	—	34	1	175	165	8	—
				1929			
1 Hale*	170	496	24	110	271	361	38
2 Elberta*	83	606	61	132	114	508	3
3 Krummel*	59	134	21	133	404	122	2
4 Hale	4	54	15	129	179	118	9
5 Elberta	31	37	20	114	124	84	2
6 Belle Georgia	18	35	5	232	331	158	8
7 Hiley	13	39	13	238	197	278	8
				1930			
1 Hale*	0	481	854	880	33	7	0
2 Elberta*	2	884	816	300	56	10	0
3 Krummel*	1	627	661	941	35	7	0
4 Hale	1	188	51	45	13	2	0
5 Elberta	2	304	98	93	16	1	0
6 Belle Georgia	0	201	150	180	12	2	0
7 Hiley	0	163	99	56	7	2	0

Legend. Catches from ten bait traps placed near the center of each variety. Nos. 1 to 8 indicate same blocks of fruit consecutive years. * Old trees, — Young trees.

DISTRIBUTION OF MOTHS DETERMINED BY CLIPPING INFESTED TERMINALS. Notes were published previously on factors contributing to

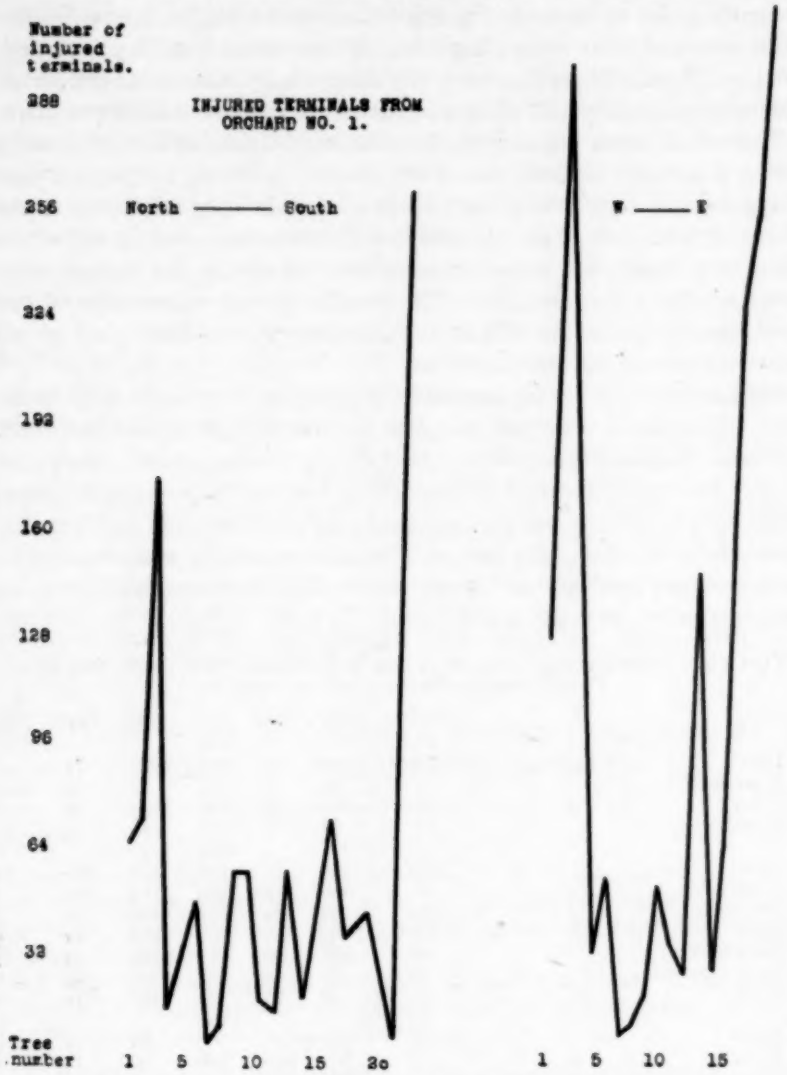

FIG. 17.—Injured terminals from orchard No. 1.

irregular distribution of moths in an orchard.[3] During 1930, considerable clipping of infested twigs was done to determine where the highest

[3]Loc. cit.

infestation occurred. Several times during the season all injured terminals were clipped from every tree in a row through the center of the orchard, from north to south and from east to west. (Table 1 and Fig. 17.) The infestation was found to be highest along the edges of the orchard. This may warrant the arrangement of baits along the edges of the orchard for control purposes. It also shows that in testing baits, great care should be used in locating the tests.

Distribution of Moths Determined by Bait Traps. The abundance and distribution of moths on different varieties of peach trees in a single orchard were studied. The bait traps were placed on separate trees near the centre of each variety. These traps were examined once a week. The location of the traps during 1928, 1929 and 1930 was nearly identical, and their operation was as near the same as possible. During 1928 the baits were replenished June 26 and August 7; during 1929 they were replenished May 29, June 23 and August 27; and during 1930 they were replenished June 11, July 29 and September 16.

Considerable difference in the number of moths caught can be noted during the months of these years (Table 2). During June 1926, 1927, 1928 and 1929, the catches were remarkably small. In 1930 the catches during June were large, and past records show that they were large during June, 1925. In 1925 and 1930, the peak of the first summer brood came before the middle of June. During 1926, 1927, 1928 and 1929 the peak of the first summer brood came in July. (Fig. 18.)

Precipitation Arendtsville, Pa.

	1928	1929	1930
April	6.75	7.00	1.96
May	3.34	5.93	1.92
June	11.04	3.70?	3.56
July	5.26	.88	.17
August	5.76	1.87	.92
September	3.86?	2.28	2.53
October	2.40	6.53	.14

In October, 1928, the catches were large in the Krummel block. This was a heavy oriental fruit moth year, and a large fourth brood went into hibernation. This, together with favorable weather during April 1929, resulted in a large emergence and large catches during this month.

The unusually dry weather during 1930 apparently had no effect upon the catches of oriental fruit moths, aside from increasing the difficulty of maintaining liquid in the traps, although it undoubtedly had some effect upon the activities of the moth, reducing the infestation. During June 1929 and June 1930, the precipitation was nearly the same,—3.70 and 3.56 respectively,—although the catches of moths were

TABLE 1. SUMMARY OF INJURED PEACH TERMINALS, ADAMS CO., 1930

	Orchard No. 1								Orchard No. 2						No. 3		
	North				East				North			East			East		
Tree	June 21	July 8	Aug. 9	Total	June 21	July 8	Aug. 9	Total	July 10	Aug. 9	Total	July 10	Aug. 9	Total	July 9	Aug. 6	Total
1	29	33	5	67	77	262	38	377	70	0	70	69	1	70	49	28	77
2	24	49	1	74	48	161	48	257	50	0	50	13	3	16	15	3	18
3	31	136	11	178	33	171	20	224	14	2	16	23	7	30	7	6	13
4	4	13	6	23	6	52	7	65	15	6	21	11	7	18	30	18	48
5	12	16	6	34	4	23	2	29	30	2	32	20	4	24	19	6	25
6	27	17	5	49	27	101	18	146	22	5	27	52	3	55	13	8	21
7	5	0	2	7	0	25	3	28	23	5	28	17	9	26	35	23	58
8	9	4	0	13	9	22	5	36	2	1	3	25	1	26	23	12	35
9	0	47	8	55	15	23	17	55	11	0	11	19	29	48	10	10	20
10	6	47	2	55	1	17	2	20	18	0	18	—	—	—	23	10	33
11	2	16	2	20	5	6	1	12	26	6	32	—	—	—	19	9	28
12	8	5	4	17	1	8	0	9	10	3	13	—	—	—	26	10	36
13	30	20	7	57	21	25	14	60	11	2	13	—	—	—	40	11	51
14	2	18	3	23	8	21	5	34	7	2	9	—	—	—	20	4	24
15	10	23	5	38	33	46	22	101	18	1	19	—	—	—	8	10	18
16	14	47	14	75	45	130	14	189	39	1	40	—	—	—	11	2	13
17	12	26	1	39	43	58	27	128	23	7	30	—	—	—	57	31	88
18	37	48	3	88	—	—	—	—	53	4	57	—	—	—	—	—	—
19	11	34	1	46	—	—	—	—	18	12	30	—	—	—	—	—	—
20	31	23	8	62	—	—	—	—	22	12	34	—	—	—	—	—	—
21	0	8	1	9	—	—	—	—	31	2	33	—	—	—	—	—	—
22	26	90	4	120	—	—	—	—	31	11	42	—	—	—	—	—	—
23	91	171	21	283	—	—	—	—	12	15	27	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	7	1	8	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	14	0	14	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	31	6	37	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	27	14	41	—	—	—	—	—	—
28	—	—	—	—	—	—	—	—	32	6	38	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—	45	21	66	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	56	28	84	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	47	53	100	—	—	—	—	—	—
		South				West				South			West			West	

quite different (Table 2). During July 1929 and July 1930, the precipitation was far below normal,—.88 and .17 inches respectively—but the catches were large both years. It would appear that normal or subnormal precipitation affects the catches of moths but little, and that other factors must account for the variation in catches. The low catches during August, September and October 1930 were undoubtedly due to the reduction of the oriental fruit moth population because of unfavorable weather conditions.

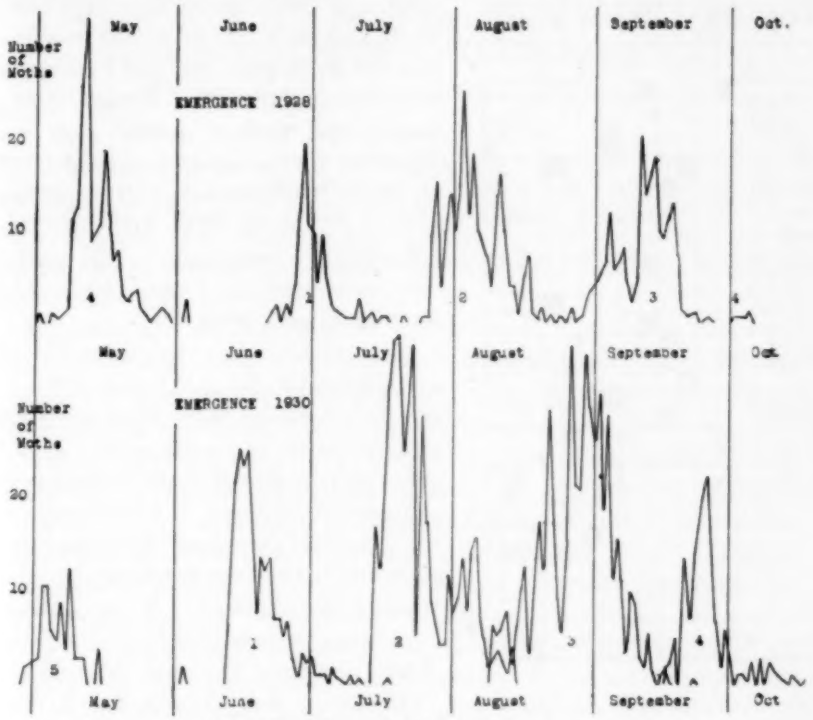

FIG. 18.—Chart showing emergence

MOTH RELEASES. Moths, males and females, marked with a .5 per cent solution of Safranin in alcohol, were released during August under two different sets of conditions. A portion of an orchard with 1,088 bearing peach trees, in which the releases were made, is shown in Figure 19. Each square represents a tree, and the moths were released from the point marked R. The orchard was equipped with 550 traps, but at the time the moths were released, the baits were not in their prime.

In releasing the moths, the following precautions were taken: (1) only newly emerged moths were used (those emerging the same day

as the release); (2) males and females were not allowed to mate before releasing; (3) sufficient time was allowed before release to be certain that the moths survived the application of the stain; (4) releases were made in the evening when little or no air was stirring.

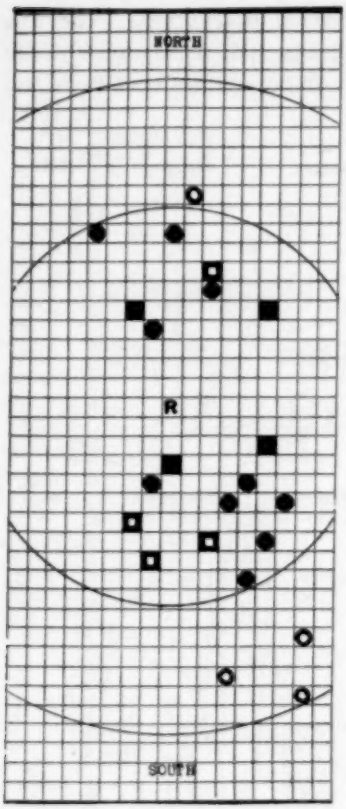

FIG. 19.—Location of oriental fruit moths recovered in bait traps. Each square represents a tree. Only a portion of the orchard is shown. From east to west it is 17 rows wide, from north to south, 60 rows long.

Solid black squares, released Aug. 4, recovered Aug. 5.
Hollow black squares, released Aug. 4, recovered Aug. 6.
Solid black circles, released Aug. 18, recovered Aug. 19.
Hollow black circles, released Aug. 18, recovered Aug. 20.

Forty marked moths were released August 4, at 7 P. M., after a thirty day period with no rain. The evening was calm, and the following two days were warm and clear. Four moths were recovered on August 5th, and four more on August 6th. On August 18th, twenty-five marked moths were released at 7 P. M., after a rain of .5 of an inch. The trees were still wet at the time of the release. The night and the following day were clear. Ten moths were recovered on August 19th; and four on August 20th.

It is evident that the moths travel a considerable distance before settling down. Some workers have released large numbers of moths upon a caged tree and remark that only a small percentage are trapped in baits hung on the tree. This is not surprising because it seems that the newly emerged moths travel a long distance. None of those in our experiments were found less than three trees from the point of release, while some were intercepted fifteen trees to the south and eight trees to the east. It is possible that they may have travelled even further, for the baits were not examined five trees beyond the most distant catch. In

both releases the moths taken on the second day were more remote from the point of release.

It is also evident that there is a tendency for the moths to migrate to the south and east, or in a direction opposite to the prevailing wind. Other experiments have shown that the moth population of an orchard is greatest near the edges of an orchard.

THE MASS PRODUCTION OF *MACROCENTRUS ANCYLIVORUS*, A PARASITE OF THE ORIENTAL FRUIT MOTH, AND ITS DISTRIBUTION FROM SOUTHERN NEW JERSEY

By H. W. ALLEN, *U. S. Bureau of Entomology, Moorestown, N. J.*

ABSTRACT

The Moorestown, New Jersey station of the U. S. Bureau of Entomology commenced work on the mass production and distribution of *M. ancylivorus* in 1929 and increased the efforts on this problem in 1930. Adults were produced in large numbers and successfully shipped and liberated in 86 colonies in 13 states. Preliminary recovery collections indicate positive recoveries from slightly less than one-half of the colonies liberated.

In 1928, Mr. Daniel, of the New York Agricultural Experiment Station, made one of the first efforts to colonize *Macrocentrus ancylivorus* Rohwer.[1] The parasites were obtained from collections made at Moorestown, N. J., and were liberated in Niagara County, New York. The effort appears to have been successful, resulting in recoveries from subsequent generations and over-winter survival. Spurred on by the need to do something to lessen the ravages of this insect, and by the apparent success of Mr. Daniel, the Dominion Parasite Laboratory of Canada and the state experiment stations of New York, Connecticut, and Indiana, in 1929 continued the work of distributing *M. ancylivorus* and used the oriental fruit moth laboratory at Moorestown as headquarters for collecting and shipping considerable quantities of parasitized insect material. The Moorestown laboratory, in 1929, tested the feasibility of shipping adult parasites of this species, and the tests proved quite successful. Through the co-operation of Dr. Philip Garman of the Connecticut Agricultural Experiment Station, Mr. W. P. Yetter and Mr. R. F. Sazama of the U. S. Bureau of Entomology at Vincennes, Indiana, and Mr. L. F. Steiner, formerly of the Indiana Agricultural Experiment Station, two colonies were placed in Connecticut, three in southern Indiana, and one in Kentucky from adults of *M. ancylivorus* shipped from

[1]Daniel, D M., Oriental peach moth parasite work in New York. Jour. Econ. Ent., vol. 23, pp. 215–217, 1930.

New Jersey. Subsequent recoveries indicated encouraging increase in the following generations and over-winter survival in Connecticut and Indiana.

In 1930 funds were provided for a definite program of mass production and distribution of *M. ancylivorus* from the Moorestown station. Under this program an effort was made to meet the greatly increased demand from the states for co-operation in their own programs of collecting parasitized larvae in southern New Jersey. In addition mass rearing has been undertaken at this station and a much enlarged program for the distribution of this parasite has been carried out. The rearing of this species en masse has presented some problems, so it has been found desirable to direct considerable attention towards the improvement of the technique of rearing.

During the past season the Canadian parasite laboratory and seven state experiment stations have used the facilities of this laboratory as headquarters for collecting parasites. This station provided information on the seasonal abundance of the hosts, the more desirable locations for collecting, insectary working space when required, and in five cases supervised the collecting and shipping of material to the various states. One hundred and twenty-eight thousand four hundred (128,400) twigs containing parasitized oriental fruit moth larvae, and 306,100 strawberry leaf-rollers, a total of 434,500 larvae were collected and shipped out of southern New Jersey to the Canadian parasite laboratory and seven state stations in 1930. The infested peach twigs were stripped, wrapped in small unit packages in paper towelling, and shipped in large mailing tubes. The strawberry leaf-rollers were collected by picking the folded leaves. The leaves were bundled and the stems wrapped in wet cotton. The bundled leaves were packed and sewed up in large cloth bags which were in turn enclosed and shipped in cardboard cartons. Material shipped in this manner arrived in good condition at points as distant as Lafayette, Indiana, and Cornelia, Georgia. Nearly all of this collecting was done between May 15 and July 25. A small amount was collected in October.

Last year it was ascertained that *M. ancylivorus* could be bred in quantities in the insectary from either the strawberry leaf-roller or the oriental fruit moth. However, a comparison of the labor expenditure for this method as compared to collecting from the field seems at present to favor the latter method by a considerable margin. Consequently, this year mass breeding on a large scale was not attempted. It was found possible to make another great gain in production per unit of labor by substituting open trays stacked in insect-tight rearing cages large

enough for men to work therein in place of the small unit containers previously used. Peach twigs infested with oriental fruit moth larvae or leaf-roller infested leaves of strawberry were collected according to seasonal abundance. The criterion for collecting was the number of parasites to be obtained per unit of time expended. This was determined by frequent field counts of larval abundance and dissections for percentage parasitism. The trimmed twigs containing oriental fruit moth larvae were placed in large cloth-bottomed trays with sufficient apples to allow the smaller larvae present to complete their development after the twigs had become dry and no longer suitable for food. Narrow strips of corrugated cardboard were tacked about the inner edge of the trays for cocooning larvae. The trays were stacked in racks within the large unit cages. The leaves containing strawberry leaf-rollers were tied in bunches of 50. These bunches were arranged on chicken wire frames in shallow metal pans containing water so that the stems were immersed but the leaves were prevented from dipping into the water. Adults emerging were collected from the walls of the cage at daily intervals by means of an electric-vacuum collecting device modelled after those in use at the European corn borer laboratory. It was found expedient to use a sliding rheostat with the collecting device so that when collecting the parasites the motor speed could be readily reduced to a point sufficient to lift the parasites gently but to avoid throwing them violently against the bottom of the collecting cone. By using an extra detachable nozzle with a small one-quarter inch aperture, it was found possible to sort out the parasites rapidly even from dense concentrations of insects on the walls of the cage. Host moths emerging were collected in the same manner and destroyed.

According to the information hitherto available, the only hosts of *M. ancylivorus* were the oriental fruit moth and the strawberry leaf-roller. Since the possibilities of attack on the first host become negligible when the larvae disappear from the twigs about mid-season, and the other known host is not abundant over much of the area infested by the fruit moth, it seemed advisable to make liberations as early as possible and when infested peach twigs were abundant, and to discontinue such liberations when the infestation had passed into the fruit. However, rearing of the host for experimental purposes was continued throughout the summer. In the fall other large collections were made to obtain over-wintering parasites for early spring liberations. In the spring 55,119 infested peach twigs and 155,300 strawberry leaf-rollers, totalling 210,419 individuals, were collected. From the peach twigs, 12,313 *M. ancylivorus* were obtained. This was 22.4 per cent of the total number of

twigs collected. From the strawberry leaf-roller, 20,164 were obtained. This number was 13.2 per cent of the total number collected. The total *M. ancylivorus* obtained during the spring collecting was 32,477, and the total production of *M. ancylivorus* adults at this laboratory during the past season was 42,267. During the fall 119,000 strawberry leaf-rollers averaging about 40 per cent parasitized by *M. ancylivorus*, and 98,000 ragweed borers with an estimated 10 per cent parasitism have been collected for over-wintering parasites from which adults will be liberated early next spring.

The adult parasites obtained were confined in small cages of 300 cubic inches capacity, up to a maximum of 500 per cage. These shipping cages were provided with water bottles, and cloth separators to increase the "roosting" area. At the beginning of the season the adults were fed on honey-water solution before packing and then shipped without food in the containers. Rather severe losses were sustained on some of the longer shipments, but when food was provided in the cages this mortality was abruptly reduced. The unit shipping cages were packed in larger crates where they were embedded in moist sphagnum. To guard against the chance transportation of the Jananese beetle from this area, the crates were enclosed in fine wire screening. Shipments were made at daily intervals to assistants in the field. In each state liberations were made through the co-operation of the state entomological stations which contributed much valuable service in the matter of selecting favorable locations and in making subsequent recovery collections. The record of liberations follows:

TABLE 1. THE RECORD OF LIBERATION OF *M. ancylivorus* IN 1930

State	Number Shipped	Number Liberated	Aver. No. of Hours in Transit	Per cent Mortality in Transit	Number of Colonies Liberated
Massachusetts	354	350	24	1.0	1
Connecticut	3,112	3,013	48	2.9	20
Maryland	527	508	40	3.5	3
North Carolina	1,766	1,641	35	7.0	4
Illinois	3,205	2,949	50	7.8	9
Ohio	4,544	3,999	45	12.0	9
New York	2,105	1,765	52	16.0	5
Indiana	3,853	3,002	46	22.1	10
South Carolina	3,525	2,476	56	29.8	8
Pennsylvania	1,700	1,111	32	34.6	4
Georgia	700	450	66	35.7	3
Tennessee	748	448	75	40.1	2
Kentucky	4,965	2,803	53	43.6	8
Total	31,104	24,515	—	—	86
Average	—	—	—	21.4	—

From Table 1, it may be seen that a total of 31,104 *M. ancylivorus* were liberated in 86 colonies in 13 states. The per cent mortality was not directly proportional to the distance at which liberated or to the time in transit as is indicated by the low mortality of those shipped to Illinois, but rather to the faulty methods used in early shipments. These methods were improved upon in the later shipments.

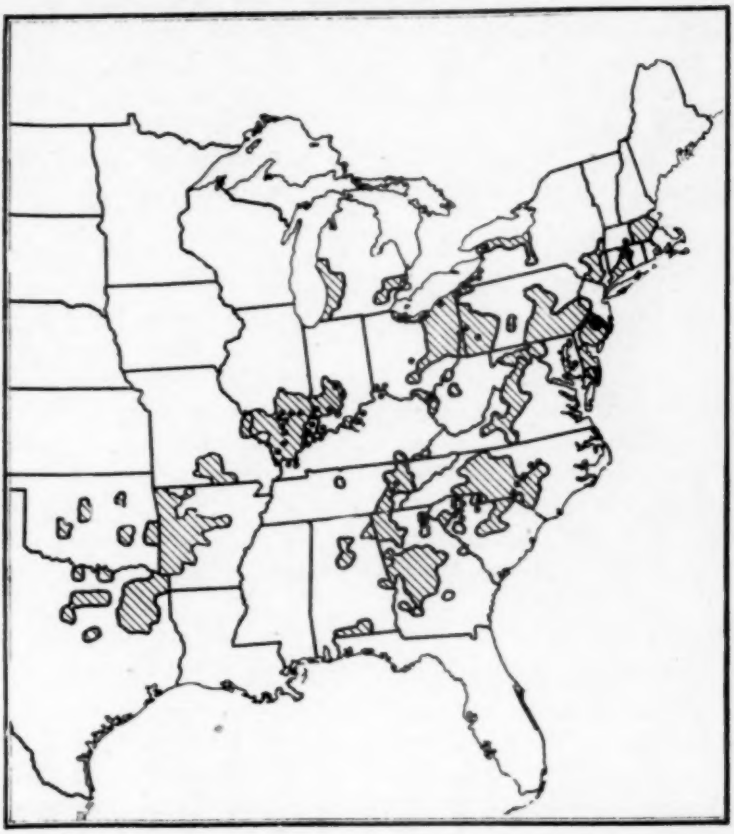

FIG. 20.—Map of eastern United States showing locations of colonies of *M. ancylivorus* released in 1930. Small dots indicate location of releasements; large dot, the area in southern New Jersey from which parasites were obtained; cross hatched areas include the counties having an excess of 50,000 peach trees in 1925 census of agriculture.

The liberations were made in the following towns: Somers, Windsor, and South Windsor in Connecticut; Cornelia and two at Alto, in Georgia; Flora, Olney, Salem, Alma, Texaco, Jonesboro, Carterville, and two at Centralia,

in Illinois; New Albany, Paoli, Shoals, Decker, Mt. Vernon, Newbury, Poseyville, Columbus, Mooresville, and Vincennes, in Indiana; Crescent Springs, Prospect, Morganfield, Jeffersontown, and two each at Henderson and Paducah, in Kentucky; Berlin, Easton, and Hancock, in Maryland; Wilbraham in Massachusetts; Fredonia, Dunkirk, Westfield, and two at Ransomville, in New York; Sanford, West End, and two at Raleigh, in North Carolina; Painesville, Avon Lake, South Amherst, Venice, Danbury, Columbus, Blue Ash, Newtown, and Procterville, in Ohio; Northeast, North Girard, Beaver Falls, and Library, in Pennsylvania; Fort Mill, Gramling, Duncan, Lowry, and two each at Greer and Laurens, in South Carolina; two at Harriman, in Tennessee. The accompanying map (Figure 20) shows the distribution of these locations in relation to the principal peach-growing counties of the eastern United States.

From 74 locations, collections of twigs infested with the fruit moth were made previous to liberation of parasites. No *M. ancylivorus* were recovered from 66. Eight were positive for this species, but 4 of these were in locations in Connecticut and Maryland in which the occurrence of this species was anticipated. The other 4 positives are at variance with the records obtained at other stations and may be erroneous owing to the possible accidental inclusion in the insectary in New Jersey of New Jersey larvae. While somewhat conflicting, the records do show that previous to liberation *M. ancylivorus* was not present in significant numbers in a very large proportion of the peach orchards outside an area east of the Allegheny Mountains extending from eastern Virginia to southern Connecticut.

Following the liberations, from one to five recovery collections were made at a majority of the liberation points. The results are as follows:

	Connecticut	Georgia	Illinois	Indiana	Kentucky	Maryland	Massachusetts	New York	North Caroilna	Ohio	Pennsylvania	South Carolina	Tennessee	Totals
Positive for *M. ancylivorus*	2	0	0	3	4	0	0	1	4	6	0	2	1	23
Negative for *M. ancylivorus*	2	2	9	4	2	0	0	3	0	2	4	2	1	31

Recoveries were thus obtained from 23 out of 54 liberations tested, or slightly less than one-half of the colonies from which recovery collections were made.

ORIENTAL FRUIT MOTH PARASITE WORK IN CONNECTICUT IN 1930

By PHILIP GARMAN

In 1929, through activities of the Connecticut Pomological Society funds were made available for breeding parasites of the Oriental fruit moth. With these funds, apparatus was constructed, stocks of parasites acquired, and the work begun during the winter of 1930. Since the equipment will be shown in slides, I will not attempt to discuss it here.

It was soon found that Macrocentrus breeding was out of the question with strawberry leaf rollers in winter because of disease among the larvae, and that production of peach moths as host could not be maintained because of mortality due to various causes. Consequently, we sent two men into New Jersey who worked in cooperation with the Federal Bureau. As a result of their work over 35,000 infested twigs and more than 15,000 folded strawberry leaves were sent to New Haven and from these 9500 Macrocentrus adults emerged. Leaves and shoots were placed in a special cage and the parasites collected as they emerged and congregated on a light screen. They were shipped in cardboard ice cream cartons packed in moist sphagnum. The collected material showed a parasitism of about 58 per cent for the peach moth larvae based on a count of the emerging moths and parasites, and a parasite for about every tenth collection, either twig or leaf. In addition Dr. Allen of Moorestown kindly supplied us with some 3,000 Macrocentrus, making a total of 12,000 secured from New Jersey. We have also succeeded in rearing since the middle of July, over 11,000 Macrocentrus, of which we now have 4,000 or more in storage. With this supply, we hope to secure a fair quantity for use next year.

During the summer 4,000,000 Trichogramma egg parasites were sent to growers with directions for handling. The yellow species was used entirely for distribution although some laboratory work was done with the dark form. About 2,000,000 additional Trichogramma were also put out experimentally, and nearly 2,000,000 more not distributed have been reared. We have lately added to our equipment and hope to double this quantity in 1931. The cost of breeding Trichogramma this year was estimated at 25 cents per 1,000 not including apparatus. Macrocentrus can be reared, we believe, at 50 cents per dozen although this year the cost was more.

In connection with some of the breeding work with fruit moths, it was found possible to rear large numbers in winter under greenhouse conditions. Thus, during February and March, 1930, we produced

12,000 eggs from which 3,000 spun larvae were secured. During the summer, we reared 12–15,000 larvae and now have 6–10,000 in storage. Our greatest egg yield amounted to more than 4,000 in a single day, though during the winter our greatest number was 1,300.

This year, we felt that every grower subscribing to the parasite fund should be supplied with parasites, and we did supply all with some. Twenty-five to 50,000 Trichogramma were supplied, the supply amounting to 12–40,000 per acre for the average grower. Macrocentrus shipments amounted to 50 or more per subscriber and varied from 15 to 50 per acre for the average grower. We believe the smaller growers have been fairly well supplied, but it is the larger growers that need further attention and we should make repeated attempts to establish both species in localities where parasites in general are scarce.

As to results of liberations, we have confined our work this year largely to production and distribution, with limited field counts and observations. Twig collections in 14 orchards showed the presence of Macrocentrus in eight of them. In six of these, Macrocentrus were liberated for the first time this year. In none of the orchards however, where Macrocentrus parasites were liberated has there been any great increase in parasitism such as has been reported in other localities. Recovery at Root's orchard in Farmington this year showed that they will pass the winter in such localities, but there has been as yet no great increase in parasitism here. The species was again collected in Barnes' orchard in Wallingford where it has been present continuously since 1925.

Results of this season's work, aside from production, are as yet hazy because of our inability to keep men consistently at field work. The unexpected reduction in fruit injury has been fortunately attributed to the parasites liberated, but there are also other factors which may have played a larger part than parasitism. These are natural parasitism and drought.

Some of the most interesting problems have been connected with production. In rearing Trichogramma, we encountered such as these: How long can eggs of grain moths be refrigerated and still be suitable for cage inoculation? How long can Trichogramma be held before shipment? What is the parasite mortality and what causes the variation or increase in ratio of males observed in 1930. With Macrocentrus breeding, how can we produce hosts in large enough quantities? What causes the unusual sex ratio encountered this summer and fall? All these questions are vital to mass production of Macrocentrus or Trichogramma under artificial conditions and it is the solution of them that makes the problem interesting.

ORIENTAL PEACH MOTH EXPERIMENTS

By DERRILL M. DANIEL, *Experiment Station, Geneva, N. Y.*

ABSTRACT

Results are given of the season's experiments with twenty insecticides to control the oriental peach moth. Partial reduction of infestation was secured in all cases. A report of the third season's work in colonizing *Macrocentrus ancylivora* Rohwer is included. The area previously colonized showed a parasitism of 54.54 per cent, a 390 per cent increase over that of last year.

As a result of oriental peach moth conferences last winter and spring, several lines of investigation were suggested which should receive particular attention. Chief among these were tests of new materials, further experiments with certain materials and combinations of insecticides already tested in certain localities, and continuance of all parasite work. This paper is a brief summary of our experiences and conclusions during the past season together with our outlook for another year.

INSECTICIDE EXPERIMENTS. Eleven dust and nine spray materials were tested, each being applied to a half-acre block of Elbertas. Fourteen orchards distributed over Niagara county were used in this work. Experimental results were determined by examination and cutting of all fruit (including drops) on four representative trees of each half-acre test plat and check. Counts were made at the time the fruit was being harvested by the grower. First the fruit showing visible injury was counted, then the remainder was split open to determine invisible injury. Table 1 gives the results secured with these materials.

Several variations in the data will be noted and may be explained by variations in infestation within the orchard. This would suggest that even half-acre blocks are too small, and it seems evident that to overcome this difficulty we will be forced to treat an entire orchard, as we do with the apple maggot and the cherry maggot, and use the average infestation of surrounding orchards as a check.

Due to the deficiency of rainfall during July and August in Niagara county, conditions were very favorable to insecticidal control. Dusts and sprays both adhered well to the fruit thruout the entire season, in fact some adhered too well. Our lime sprayed blocks were unsalable. Considering the number of applications and the necessity of removing the spray residue we are convinced that no lime sprays will be used in New York regardless of the reduction of infestation secured.

PARASITE EXPERIMENTS. Work of the past two years in colonizing *Macrocentrus ancylivora* was continued during the past season with gratifying results. The work was again centered in Niagara county, the

TABLE 1. REDUCTION OF INFESTATION BY INSECTICIDES

	Dusts	Number Applications	Percentage Reduction
1	Sulphur, lead arsenate, lime, S. oil	10	75.32
2	Sulphur, lead arsenate, lime, F. oil	11	38.72
3	Sulphur, lead arsenate, lime, C. oil	11	60.75
4	Lime, lead arsenate, S. oil	12	0.51
5	Lime, lead arsenate, F. oil	12	26.24
6	Lime, lead arsenate, C. oil	12	45.63
7	Cryolite, lime	14	29.39
8	Talc	13	0.71
9	Kalite	3	38.21
10	Talc, lead arsenate, brown sugar, molasses	6	37.50
11	Nicotine	1	42.39
	Sprays		
1	Medina Summer oil	6	80.84
2	Volck Summer oil	6	79.61
3	Cryolite, F. oil	6	12.24
4	Lime 30–100	8	40.50
5	Lime 50–100	8	14.15
6	Lime 30—100, Medina Summer oil	9	42.85
7	Lime 30–100, Volck Summer oil	8	63.17
8	Lime 50–100, Volck Summer oil	8	0.02
9	Lime 50–100, Medina Summer oil	8	39.08

"S. oil" = White Oil No. 4, Standard Oil Co. of New York.
"F. oil" = Menhaden Fish Oil.
"C. oil" = Cocoanut Oil.
Sulphur is 300-mesh dusting, lime is Bald Eagle Brand.

principal peach county of the state. Nineteen liberations were made in this county and recoveries were secured from field collections made at all of these points. Releases this year, together with those of the first two years have established colonies over three-fourths of the county. In the general area where the species was established two years ago we find an average parasitism of 54.54 per cent, as compared with last year when a parasitism of 13.79 per cent was recorded. This is an increase of better than 390 per cent over that of last year. Ninety per cent of this parasitism was due to *M. ancylivora*. We also find that parasitism by native species which was negligible in previous seasons, has increased appreciably. Fruit infestation in this area was from 50 to 60 per cent lower than last year. However, some of this reduction was undoubtedly due to the increased amount of fruit this year.

EXPERIMENTS WITH WHITE OIL-PYRETHRUM FOR THE CONTROL OF THE ORIENTAL PEACH MOTH[1]

By BYRLEY F. DRIGGERS, *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Laboratory experiments with white oil-pyrethrum sprayed on new and old peach twigs showed that newly hatched peach moth larvae (*Laspeyresia molesta*) are killed more easily when they crawl over sprayed new growth than sprayed old growth. The difference appeared to be due to the greater absorptive power of the old growth for the oil. Field spraying tests in which white oil-pyrethrum was used at 0.5 and 1 per cent on a five day schedule against third brood eggs and larvae showed a reduction in invisible fruit infestation of from 60 to 75. Visible fruit infestation, which was comparatively high at the time the spraying operations were begun, was reduced much less by the spray so that the combined visible and invisible injury gave a total reduction in fruit infestation of from 30 to 70 per cent. The effect of parasites on the seasonal activities of the peach moth and their relation to spraying operations are discussed.

Field spraying experiments in which pyrethrum impregnated white oil was used as an emulsion were carried out in 1928 and 1929 in an effort to control the Oriental Peach Moth on peaches. The diluted spray contained one-half per cent actual oil in 1928 and one per cent in 1929. Applications of the spray were made at weekly or ten day intervals in both years from the last week in July to the end of August. Neither the one-half per cent spray of 1928 nor the one per cent spray of 1929 gave any decided increase in clean fruit. There was on hand evidence obtained in experiments carried on with talc in another orchard which would indicate that the effectiveness of the spray was lessened by the oil reducing the activities of certain peach moth parasites. It was thought, however, that there was some other factor or factors entering in to cause the discrepancy between the insectary and field results. In the spring and early summer of 1930 the writer carried on experiments in the greenhouse and insectary to determine (1) why larvae were able to gain entrance in peaches in the field in spite of the weekly applications of a one per cent white oil-pyrethrum spray and (2) to modify or improve the white oil-pyrethrum sprays to increase the egg and larval kill in the field.

EFFECTIVENESS OF THE OIL FILM ON NEW AND OLD PEACH TWIGS. The possible effect of the oil on parasites of the peach moth has been mentioned. The next step was to study the relative kill of young larvae

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

crawling over oil films on new and old peach twigs. The eggs of the peach moth are laid on peach mostly on the underside of the leaves. In midseason or later when the peach twigs become hardened the newly hatched larvae make their way to the fruit. Quite often the larvae crawl over a considerable area of old twig growth before they reach the fruit. It was thought that an oil film on twigs of the previous season's growth might be absorbed to a greater extent than an oil film on twigs of the current season's growth. If such was the case larvae might be able to reach the fruit before coming in contact with a sufficient quantity of the oil to kill them.

To test this theory the writer collected twigs of the current and previous season's growth and cut them into convenient lengths of 3 to 4 inches. These twigs were sprayed with a one per cent white oil-pyrethrum emulsion. As soon as the twigs were dry, peach leaves on which peach moth eggs had been deposited were attached to one end of the twig. The other end of the twig was attached to an apple. Eggs of different ages were used so that larvae would be hatching and making their way over the oiled section of twig from a few hours to a day after the twigs were sprayed. Four tests were run using five old and five new twigs in each test. A total of 222 larvae were used on the old growth and 217 on the new growth. Thirty-one per cent of the larvae were killed as they made their way over the oil sprayed new growth and only 1.8 per cent were killed on the old growth. No effort was made to determine the fate of those larvae that reached the apple. Those larvae that succeeded in reaching the apple were counted as live.

The results from these experiments showed clearly that when new and old peach twigs are sprayed the same with oil-pyrethrum, the kill of larvae crawling over the twigs is considerably higher on the new growth. The woody or corky nature of the twigs of the previous season's growth appeared to absorb the oil more rapidly than the twigs of the current season's growth. Experiments were continued in the laboratory along the line of changing the proportions of the spray ingredients, or adding to the spray certain materials of a sticky nature in an effort to develop a combination that was more effective in stopping the larvae. None of the spray combinations tried proved particularly promising. It was found however that fibrous talc dust to which white oil-pyrethrum was added up to five per cent was more effective in killing the young larvae than the talc without the oil. The difference appeared to be due mostly to the better sticking quality of oil-talc. The results of the laboratory tests indicated that the field tests with the oil emulsion should be aimed at killing a greater proportion of the eggs. Accordingly the field tests

with oil emulsion were run in orchards at Dayton and South River, New Jersey, using the oil at one-half and one per cent with applications timed and the spray applied in such a way as to kill the maximum number of eggs during the month previous to the date of fruit ripening. In addition to the spray tests the writer ran a test using fibrous talc to which white oil-pyrethrum was added to the extent of two per cent.

FIELD TESTS AT DAYTON, N. J. At Dayton a block of 225 four year old peach trees, consisting of the three varieties Delicious, Radiance and Eclipse, were sprayed with a white oil-pyrethrum emulsion. The highly refined white oil, to which a concentrated kerosene extract of pyrethrum was added to bring the pyrethrum content of the oil up to the equivalent of ¾ pound flowers to a gallon, was used at one-half per cent actual oil. The oil was emulsified in the field by using 1/3 water, 2/3 oil and enough dry powdered milk to bring the milk content of the stock emulsion up to two per cent. The entire block of trees was sprayed with the exception of one row of 15 trees running across the three varieties in the center of the block. The block was sprayed on July 23, 28 and August 2. The five rows of Eclipse which ripened later than the other two varietes, were given two additional applications on August 7 and 12. The spray was applied with a three nozzle rod and an effort made to wet the underside of the leaves.

The ten rows of Delicious and Radiance varieties were picked August 6 and 7 and the five rows of Eclipse on August 15 and 16. In previous years the method used in determining the results of field tests was to pick all the fruit on five or ten trees in the sprayed block and examine all the fruit for visible and a part (usually 1/3) of the fruit for invisible injury. The same procedure was followed on five or ten check trees for a comparison. It was decided to compare this method with another wherein 100 fruits were to be picked at random from each of ten trees on the sprayed block and each of ten trees from the check block and the fruit examined for visible and invisible injury. The percentages of injured fruit on the Delicious and Radiance trees sprayed three times and on the Eclipse sprayed five times as compared to the percentage of injured fruit on the checks as obtained by the two methods are set forth in Table 1.

Table 1 shows that the reduction in the invisible injury as a result of the spray amounted to from 60 to 75 per cent. The visible injury on the sprayed fruit was not greatly reduced over that of the check. This was to be expected since most of the visible injury consisted of old injury caused by larvae of the early broods before spraying began. The visible

injury combined with the invisible injury gave a total reduction of from 30 to 50 per cent. Table 1 shows that the two methods of determining the amount of injury gave about the same results.

TABLE 1. PERCENTAGE OF INJURED FRUIT ON SPRAYED AND UNSPRAYED TREES AS DETERMINED BY (1) EXAMINING ALL FRUIT ON A GIVEN NUMBER OF TREES AND (2) EXAMINING 100 FRUIT FROM EACH OF A GIVEN NUMBER OF TREES

Treatment	Method of Counting	No. Trees	Total Fruit	Percentage Fruit Injured Visible	Invisible	Total
	Delicious and Radiance Varieties Sprayed 3 Times					
Check	Old	5	1647	4.0	3.2	7.2
	New	10	1000	4.80	2.60	7.4
Spray	Old	10	2807	3.9	0.80	4.7
	New	20	2000	4.15	1.05	5.2
	Eclipse Variety Sprayed 5 Times					
Check	Old	5	1111	9.0	3.7	12.7
	New	5	444	10.1	3.3	13.4
Spray	Old	10	1899	5.0	1.2	6.2
	New	10	890	6.1	0.8	6.9

At Dayton also an Elberta, a Fox Seedling and an Iron Mountain block of peaches were sprayed with a one-half per cent white oil-pyrethrum spray on a five day schedule beginning four and five weeks before date of ripening of the fruit. A row of trees in each of the three blocks was left unsprayed to serve as a check. The total reduction in the amount of injured fruit as a result of the spray was approximately fifty per cent on each of the three varieties. The peach moth injury on these late varieties at Dayton was surprisingly low. Fox Seedling for instance, which ripens later than Elberta, had only five per cent injured fruit. The detailed results from the tests on these three varieties are omitted.

FIELD TESTS AT SOUTH RIVER. Spraying tests were run at South River on Elbertas and Georgia Belles in the same orchard where the 1928 and 1929 oil tests were run. Two blocks of twenty trees each were laid out in the Elberta orchard. One block was sprayed on a five day schedule and the other on a ten day schedule. The highly refined white oil was impregnated with the equivalent of 1¾ pounds flowers per gallon and the final spray contained one per cent actual oil Applications were made with a three nozzle spray rod and efforts made to hit the underside of the leaves with the spray. The five day schedule block was sprayed July 22, 26, 31 and August 5, 11, 18 and 25. The ten day schedule block was sprayed July 22, 31 and August 11 and 25. The fruit was picked and examined for injury August 28–31. All the fruit on 12 check trees and on nine or ten trees in each of the two spray blocks was examined for visible and invisible injury. The results are set forth in in Table 2.

TABLE 2. PERCENTAGE OF INJURED PEACHES ON UNSPRAYED TREES AND ON TREES SPRAYED WITH 1 PER CENT OIL ON A 5 DAY AND 10 DAY SCHEDULE IN AN ELBERTA ORCHARD

Treatment	No. Trees Counted	Total Fruit	Per Cent Fruit Infested		
			Visible	Invisible	Total
Check	12	1217	17.1	7.2	24.3
Sprayed 5-Day Schedule	10	952	13.0	2.4	15.4
Sprayed 10-Day Schedule	9	913	13.1	3.1	16.2

The orchard where these tests were run was heavily infested with peach moth the previous year. With a full crop in 1929 the fruit ran approximately 60 per cent infested. This past season there was only one-third of a crop on the trees and the fruit at the beginning of the experiment showed a visible infestation of from ten to fifteen per cent. It was thought that with a light crop and a heavy first brood infestation the 1930 crop would run much higher than the 60 per cent infestation of 1929 and thus allow for a severe test of the spray. The total infestation of the fruit at picking time was approximately 25 per cent, which was less than half the infestation of the year before. Table 2 shows that there was little reduction in the visible injury on either the five day or ten day block. The visible injury on the two sprayed blocks remained about the same as it was at the beginning of the test. The invisible injury was reduced about 65 per cent on the 5 day block and about 55 per cent on the 10 day block. The total infestation was reduced less than forty per cent on either spray block due to the comparatively high initial infestation.

Five heavily fruited trees in a Georgia Belle orchard adjoining the Elberta orchard at South River were sprayed on an approximate five day schedule, using a one per cent white oil containing 24 per cent pyrethrum. The trees were sprayed August 5, 11 and 18 and harvested August 26. The effect of the treatment was determined by picking 200 fruit at random from each of the five sprayed trees and each of five adjoining check trees. The fruit was examined for visible injury and then cut to determine the invisible injury. The results are set forth in Table 3.

TABLE 3. PERCENTAGE OF INJURED FRUIT ON FIVE CHECK TREES AND FIVE TREES SPRAYED THREE TIMES WITH 1 PER CENT OIL-PYRETHRUM. TREES WERE HEAVILY FRUITED GEORGIA BELLES

Treatment	No. Trees	Total Fruit	Per Cent Fruit Infested		
			Visible	Invisible	Total
Check	5	1000	8.5	5.8	14.3
Sprayed	5	1000	3.3	1.4	4.7

Table 3 shows that the three sprays on the Georgia Belles reduced the visible injury approximately 60 per cent and the invisible approx-

imately 75 per cent. The reduction in total fruit infested on the sprayed trees as compared to the check trees was approximately 70 per cent.

OIL-TALC DUST TEST AT FLEMINGTON. A block of 20 Hale and Elberta trees in an orchard near Flemington was dusted with fibrous talc treated with white oil-pyrethrum. The white oil which was impregnated with the equivalent of 1¾ pounds flowers per gallon was mixed with the talc so as to make a two per cent oil dust. The block was dusted seven times during July and August. Examination of 100 fruit on each of ten trees in the dusted block and each of ten trees in the check block at the time of harvest showed a total infestation of 5.1 per cent on the check block and 2.6 per cent on the dusted block. Although these figures show approximately a fifty per cent reduction in wormy fruit by the use of the talc dust and oil, the reduction of the moth population in this orchard by natural agencies was so great that no artificial control was necessary. It is interesting to note that according to the owner of the orchard approximately half of the Hale and Elberta crop was wormy in 1929.

DISCUSSION. In 1929 Elberta peaches in three out of four orchards where the writer made counts were wormy to the extent of 50 to 80 per cent. The 1930 season started with indications that the peach crop in New Jersey would be as wormy as that of 1929 if not more so. There was a heavy carry over of larvae through the winter and, with an early season speeding up moth emergence, many orchardists failed to plow under trash and mummies in time to prevent a considerable number of the moths from emerging. The heavy spring brood of moths resulted in a heavy twig infestation by larvae of the first brood. As the season advanced there appeared to be more injury to green fruit from larvae of the first and second broods transferring from twigs to fruit than in former years. By the time third and fourth brood larvae were due to appear in the field natural agencies, presumably parasites mostly, had so reduced the moth population that fruit during the latter part of July, the months of August and September were comparatively free from attack by larvae. In some orchards the earlier ripening varieties were more wormy when harvested than the late varieties. For example, Eclipse and Elberta at Dayton were wormy to the extent of 12–14 per cent whereas Fox Seedling was 5 and Iron Mountain 7 per cent wormy.

All of the field tests in 1930 were aimed at eggs and larvae of the third and later broods. The results from the oil-pyrethrum sprays, applied at a time of light and diminishing infestation, show reductions in invisible injury of from 60 to 75 per cent where the spray was applied on a five day

schedule. This percentage is based upon the relation of the check block infestations to the treated blocks. There is a question whether the same relative percentages on check and treated blocks can be reproduced under conditions of heavy and growing infestations. This question can be answered only by trying the treatment under such conditions. It is thought that a large number of eggs deposited by the third and later broods might give different results in fruit infestation in spite of the fact that the same percentage of eggs were killed as were destroyed under conditions of light and decreasing infestation, because the percentage of eggs not killed under conditions of heavy and growing infestation would involve a greatly increased actual number of larvae, enough of which might reach the fruit to produce a very high fruit infestation. If egg parasites were working vigorously in the unsprayed but not in the sprayed trees, the actual percentage of hatched larvae in the check block might be no greater, if as great, as the actual percentage of hatched larvae in the sprayed block.

These conditions and this reasoning indicate the need of a considerable reduction in the first and second broods in order that the stock of the insect in the third and later broods may be greatly reduced. It is a well known fact in insect control, especially with codling moth, that light infestations are easy to control and heavy infestations are difficult to control. The problem of reducing the first and second broods may be attacked from several angles. One is a propagation or encouragement of twig parasites against the early broods and another is the use of mechanical barriers, such as talc or lime, in the early season sprays. Measures directed against the overwintering larvae may be developed also that will be effective in reducing the moth population of the early broods.

Scientific Notes

An Overlooked Suggestion Regarding Possible Practical Use of Parasites. I think that entomologists have universally overlooked a significant suggestion made as early as 1872 by B. Pickman Mann. This entomologist, it will be remembered, devoted himself during the early part of his career almost entirely to the bibliography of entomology, and was for many years the editor of *Psyche*. Back in the early 1870's, at a suggestion made to Louis Agassiz by the then Emperor of Brazil, Dom Pedro, Mann was sent to Brazil to investigate injurious insects, especially those affecting coffee. His report on the white coffee leaf-miner was published in two instalments in the *American Naturalist* for September and October, 1872. He described the life history in considerable detail and made the suggestion that the leaves of the coffee tree as they fall should be collected and burned. However, he had observed two parasites of the miner, namely an Eulophus and a Braconid, and he made the suggestion (anticipating, so far as I know, any similar suggestion made by

an American) that before the picked leaves are burned they should be placed in a compartment from which the moths could not escape and allowed to lie there until the insects develop. He suggested that this compartment should be made with glass sides, so that the parasites issuing from the leaves could be captured on the glass and transported to parts of the country where they might be needed.

L. O. HOWARD, *U. S. Bureau of Entomology*

Chinese Vitex Introduced into Haiti. Logwood, which is the most valuable honey plant in Haiti, is being rapidly cut out for the dyewood industry and in many sections is not re-seeding itself very fast on account of a small Eurytomid wasp that destroys the seeds. In certain sections over 90% of the seed have been destroyed during the season of 1930. It, therefore, seemed a well-worthwhile undertaking to introduce and establish the Chinese Vitex tree as it is a wonderful producer of fine quality nectar and is able to withstand heat and drouth and reported as being quite resistant to alkali soil. Seed received through the kindness of the Foreign Plant Introduction office of the U. S. Bureau of Plant Industry were planted June 9th in a specially prepared seed bed in lath house and started to germinate on the sixth day. Growth was satisfactory and the young plants were transplanted to paper pots and kept in these for about a month and a half under partial shade. During the period September 4 to October 30, 1930 a total of 856 of these young plants were distributed over the Island into the hands of over seventy individuals, representing mostly apiculturists, and at a number of the farm schools, in many different types of soil and climate. Three of the oldest plants, set out in the field on September 4th, in finely colloidal, "black gumbo" soil, started to flower on November 16th at heights of one and one-half to three feet, exactly five months from the date they first came through the ground in the seed bed. Favorable reports are coming in from different sectinos and the introduction appears to be successful.

HERBERT L. DOZIER, *Chief Entomologist, Service Technique, Port-au-Prince, Haiti*

Tarnished Plant Bug Injury to Beans. So-called "puncturing" of beans has been increasing in extent for several years in the bean growing areas of Southern Idaho. This injury became so serious in 1929 that it caused a reduction in the grade of beans that otherwise were of first quality, resulting in considerable monetary loss to the growers. The injury occurs but is of less economic importance in Northern Idaho. "Puncturing" appears as a small hole in the seed coat beneath which are large loose granules of starch. The area immediately surrounding the hole is a light brown color. The first definite record of this injury in Idaho is contained in a riker mount of injured beans collected at Twin Falls prior to 1916.

The Idaho Agricultural Experiment Station in the summer of 1930 began a study of the injury in order to determine the cause. Cages were set up in the field, insects were collected from bean plants and into each cage was introduced a species which it seemed probable might cause the type of injury observed. Characteristic "puncturing" was produced only in cages containing the tarnished plant bug, *Lygus elisius*. Furthermore, this injury was produced to greater or less extent in every cage into which *L. elisius* was introduced. Populations of the tarnished plant bug in bean fields, as determined by extensive sweeping, were large at certain periods of the summer.

Beans which were artificially punctured with a needle did not show the characteristic large, loose starch granules in the cotyledon beneath the point of incision, but did develop the light brown color.

"Puncturing" has been most prevalent on the Great Northern variety of beans. Butternut beans, on which were found large numbers of tarnished plant bugs, showed practically no injury to the harvested beans. The first named variety has a relatively thin walled pod while the latter variety has a very thick walled pod during most of its period of growth.

W. E. SHULL and CLAUDE WAKELAND, *Idaho Agricultural Experiment Station, Moscow, Idaho*

Removal of Leafhopper Specking from Apples. Leafhopper specking (caused principally by *Typhlocyba pomaria* McAtee) was so serious on apples in some orchards of the Shenandoah-Cumberland Valley fruit section that its removal was necessary before a U. S. No. 1 grade could be packed. The only practical method of removal proved to be washing the fruit in a commercial washer equipped with a towel drying unit. The action of the hydrochloric acid and water solutions soaked the specks sufficiently for the towels to remove all of the specking, except for an occasional spot deep in the stem end. The specking was more effectively removed by the towels after the fruit had passed through the hydrochloric acid wash than when no acid was used. There was no evidence of removing leafhopper specking from any type of washing machine, except the machines with the towel drying unit. Dry cleaning equipment such as the wiping or polishing machines commonly used were not effective. Specking was removed from all varieties affected in the Shenandoah-Cumberland Valley section. Through the courtesy of Dr. P. J. Chapman of the New York Experiment Station, we received a sample of Rhode Island Greenings which showed a fairly large amount of specking. This proved to be the only variety from which we were unable to remove nearly all of the spots by passing the fruit through the washer once. At the time the Rhode Island Greenings were washed the acid solution tested only .25% (about 3 quarts acid in 100 gal.). Judging from previous experience we should have obtained a more satisfactory removal of the specking, if as much as 2 gallons of acid per 100 gallons of wash solution had been used. For most cases of specking, however, we have found 1 gallon of acid per 100 gallons of wash solution to be sufficient.

W. S. HOUGH, *Virginia Experiment Station, Winchester, Virginia*

Tomato Vines Injured by a Mirid (*Engytatus geniculatus* Reuter). During the past three years or more the writer has observed in the vicinity of El Paso, Texas and in the Sulphur Springs Valley, Arizona, a peculiar case of insect injury in tomato fields. The condition was first brought to my attention by the fact that in walking through the fields I accidentally broke off a number of stems or leaves.

Examining the surface of the break, I found a brownish discoloration in the cortical tissues. Upon further investigation it was noted that a large number of the stems had been more or less completely girdled at various points, extending over as much as two feet. The older girdles were swollen, with a very narrow brownish ring at the apex of the swelling, and were quite resistant. The younger girdles were merely a narrow ring of brownish discoloration and at such points the stems or petioles broke off very readily.

Still closer to the growing point it was possible to find small spots of discoloration, though no definite girdles were detected. At the points of discoloration, the stems did not readily break.

From the beginning of this observation, I found rather small green mirids quite abundant on the plants. They were especially prevalent at the very tips of the stems among the unfolding leaves, flower buds, etc. The past summer I collected several specimens and sent them to Mr. E. P. Van Duzee of San Francisco, who identified them as *Engytatus geniculatus*[1] Reuter. Mr. Van Duzee called my attention to the fact that this insect had been reported as causing injury to tomatoes in the Hawaiian Islands. Professor R. W. Doane of Stanford University, to whose attention I brought this condition, has been kind enough to look up the literature and has sent me extracts from the Journals which state that Illingworth attributed the failure of tomatoes to set fruit in the Hawaiian Islands to the presence of the above named mirid in the flowers.

While it may be said that I have not conclusively proved that the girdles on tomato stems are due to this insect, there seems to be a fairly definite case against the pest. As to the possible effects of the girdles on the shedding of blossoms and the yield of the plants, one may assume that there is a significant relationship.

WYATT W. JONES, *Douglas, Arizona*

Tests with Paradichlorobenzene-Oil Emulsion Against the San Jose Scale. Since the writers have found paradichlorobenzene dissolved in cottonseed oil to be very effective against the lesser peach borer, it occurred to them that a weak lubricating-oil emulsion containing paradichlorobenzene might be effective against the San Jose scale. Consequently, an experiment was conducted to determine the effectiveness of a soap-lubricating oil emulsion containing paradichlorobenzene when applied as a spray at strengths of 0.25, 0.5, 1, and 1.5 per cent oil for San Jose scale control. The emulsion was made with an oil having a viscosity of 168 seconds, Saybolt, and a volatility of 0.60 per cent, in which paradichlorobenzene had been dissolved at the rate of 2 pounds to 1 gallon. Potash-fish oil soap was the emulsifying agent employed. Each plat contained five Early Rose peach trees which were infested with live scale. The following table gives a summary of the results. (See p. 329.).

The scale mortality from the several strengths of paradichlorobenzene-oil emulsion was about that which can be expected from the same strengths of lubricating oil emulsion. Apparently the addition of paradichlorobenzene to the emulsion does not increase the effectiveness of that insecticide for scale control.

OLIVER I. SNAPP and J. R. THOMSON, *U. S. Peach Insect Laboratory, Fort Valley, Georgia*

Genuine Derris Root may Contain no Rotenone. Certain British producers have been offering derris root on the basis of 3 cents for each .01 pound of ether extract. A root assaying 15 per cent total ether extract would bring 45 cents a pound on this basis.

It may be true, as represented by certain producers, that all the matter extracted by means of ether from derris root has some insecticidal value, and further investigation may show that the constituents other than rotenone are equal or even superior to rotenone for the control of certain pests, but the experiments of Davidson [J. Econ. Ent. 23: 877 (1930)] with pure compounds isolated from the ether extract of derris

[1]Only reported from Florida and Texas in Van Duzee's Catalogue.

Plat No.	Number of Scales Counted Jan. 15, 1930	Average percentage of Scale Alive Jan. 15, 1930	Trees Sprayed Jan. 16, 1930, with Para.-Oil Emulsion at Strength of—	Number of Scales Counted Feb. 26, 1930	Average percentage of Scale Alive Feb. 26, 1930	Average percentage reduction of Live Scale as Result of Spraying
			Per cent			
1	948	84.9±.5	0.25	1,000	80.9±1.0	4.7
2	958	83.7±.8	0.50	926	46.0±1.0	45.0
3	898	86.5±.4	1.00	1,000	25.3±3.2	70.8
4	883	84.7±.9	1.50	1,000	14.2±2.8	83.2
5	770	83.2±.9	Check (untreated)			
All Plats	4457	84.7±.3		1,000	82.3±.4	

root and all other information now at hand indicate rotenone to be far superior in insecticidal value to deguelin, tephrosin and toxicarol, and undoubtedly the most valuable constituent of derris.

Numerous samples of root sold as derris root have been examined recently in the Insecticide Division of the Bureau of Chemistry and Soils, and several have been found to contain no rotenone. The method of analysis used, which depends on the fact that rotenone is less soluble in ether than the other constituents of the root, yields results that are slightly low, but no better method is known. This method is described by Roark in the Malayan Agricultural Journal, volume 18, No. 9, p. 456, September, 1930. All samples of derris root analyzed in the Bureau have been examined microscopically by George L. Keenan, Microanalyst for the Food and Drug Administration, and have been found to be identical with authentic specimens. It has not been possible to differentiate the species of the plant by microscopical examination of the root alone, and the chemical differences found by us may be attributable to a variation in species or variety. On the other hand they may be due to variations in the age of the roots or in the conditions under which the roots were grown.

We have found the rotenone content of derris root to range from 0 to 5.5 per cent, and the total ether extract to range from about 5 per cent to 23 per cent, but there is no consistent relation between the two. For example, the bale of root, imported through a New York dealer, that contained 23 per cent total ether extract contained no rotenone.

Not only does the total amount of toxic constituents in derris root vary greatly, but the composition of the extract, that is the ratio of one constituent to another, also varies. Two bales of derris root, imported from Sumatra were found to be rich in toxicarol but entirely lacking in rotenone.

Since derris root is highly variable, it is to be expected that extracts prepared from it are likewise not uniform. This nonuniformity in proprietary derris preparations, both powders and extracts, accounts for many of the inconsistent results reported by entomologists.

Two per cent rotenone is about all that can be expected in the usual derris root now on the market.

Cubé root (*Lonchocarpus nicou*) from South America has been found by the Insecticide Division to contain up to 7.6 per cent rotenone. If producers are unwilling to supply derris root on the basis of a guaranteed rotenone content they may find consumers turning to cubé root, which is just becoming commercially available. According to recent information, an extract of cubé root prepared in Peru or Brazil may soon be placed on the American market.

R. C. ROARK, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

Length of the Developmental Stages of the Horn-Fly, *Haematobia irritans* (Linne), at Constant Temperature. Although several valuable papers have been published regarding the life cycle of the horn fly, *Haematobia irritans* (Linne), under field conditions, our knowledge of the life history of this important stock pest under constant temperature conditions is very limited. During the summer of 1930 a few notes were made on the length of the developmental stages at constant temperature. A brief presentation of these notes follows:

INCUBATION PERIOD: Eggs were obtained by placing wild gravid females in shell vials plugged with cotton. The eggs were removed every 15 minutes and placed on moist toweling paper in small ground glass top stender dishes. The stender dishes were placed immediately in constant temperature ovens. During time of hatching examinations were made every 15 minutes and the larvae removed and recorded. Results of these studies are summarized below:

Temperature	No. Observations	Range in hours and minutes	Wt. mean time in hours and minutes
25°C.	944	17:15–21:45	19:39
30°C.	2622	13:15–16:20	14:25

EGG, LARVAL AND PUPAL PERIOD: Fresh cow dung was caught in battery jars, 15.5 cm. in diameter x 20.5 cm. high. The jars were covered immediately with cheese cloth and placed at 30°C. Gravid female horn flies were introduced into the jars and allowed to remain for six hours. During time of emergence the flies were removed every two hours and the number recorded. The mean time of exposure and of emergence were used, thus the results are expressed as ± 4 hours. The results of these tests are tabulated below.

TABLE 1. SHOWS LENGTH OF DEVELOPMENTAL STAGE OF THE HORN FLY, *H. irritans* (LINNE) AT 30°C.

Jar No.	No. of Adults Emerged	Range in Hours	Weighted Mean Time in Hours
1	427	208–260	229.0
2	345	210–269	238.0
3	203	210–242	226.6
4	294	222–269	242.2
5	83	224–273	249.0
6	206	224–273	251.2
7	311	208–273	238.5

SUMMARY: From the data presented above the following tentative conclusions are drawn.

Incubation period at 25°C.....19 hrs. 39 min.
Incubation period at 30°C.....14 hrs. 25 min.
Egg, larval and pupal period at 30°C.....238.5 hrs. 4 min.

ROY MELVIN and D. E. BECK, *Department of Zoology and Entomology, Iowa State College, Ames, Iowa.*

The Papaya Fruit Fly in Puerto Rico. In the spring of 1930 permission was requested of the U. S. Plant Quarantine and Control Administration, by the Commissioner of Agriculture of Puerto Rico for fresh papaya fruits to be shipped to the States. The matter, however, was held in abeyance because of the known presence of the papaya fruit fly, *Toxytrypana curvicauda* Gerst. in the Island, and the request made that the present status of the pest be more definitely determined.

A thoro examination of the literature and of local records disclosed the fact that the occurrence of the papaya fruit fly in Puerto Rico rests solely upon a statement by C. W. Hooker published in 1913 (Ann. Rept. Porto Rico Agr. Exp. Sta. for 1912, p. 36, 1913). As this is apparently based on actual observation we quote it here: "The lechosa fruit fly (*Toxytrypana curvicauda*) is abundant at Mayagüez and has been reported from St. Johns, Antigua, West Indies; Brazil, Peru, and Yucatan. The adult is a large bright yellow fly with black markings, yellowish transparent wings, and a long—14 mm.—curved ovipositor. The eggs are laid well below the surface of the green fruit; 2 to 15 or more larvae mature within the fruit, and when it drops pupate 1

or 2 inches below the surface of the ground immediately below the fruit. Adults emerge in 17 to 21 days, and eggs for another brood are soon laid. Spraying with sweetened arsenate of lead and daily destroying the drops should soon control the lechosa fruit fly, tho the adults are strong fliers."

Wolcott refers to the above statement in his List (Jour. Dept. Agr. P. R. 7 (1): 229, 1923) and also refers to Van Zwaluwenburg's typewritten check list of Porto Rican insects prepared in 1914 where the species is listed as represented in the collection of the Mayagüez Station based only on specimens bred by Hooker. The Insular Experiment Station collection contains 4 adults—2 males and 2 females—bred by Hooker at Mayagüez in June and in November 1912. Additional adults are also in the collection at Mayagüez.

Since careful and widespread inquiry among the Agricultural Agents, growers, and others, all failed to bring forth a statement of maggots ever having been noticed in papayas, a survey was made from July 28 to August 2, 1930 in company with Mr. Richard Faxon of the U. S. Plant Quarantine and Control Administration Office in San Juan and Mr. L. A. Catoni, Chief of the Insular Plant Quarantine Service, This was designed to cover towns along the coastal sections and also in the higher parts of the Island. The following localities were visited: San Juan, Rio Piedras, Vega Baja, Arecibo, Lares, Utuado, San Sebastián, Mayagüez, Sabana Grande, Ponce, Collores, Juana Díaz, Aguirre, and Cayey, and included elevations from sea-level to about 2000 ft. About 369 trees were examined in all, containing about 3000 fruits, including fruits examined in the market at both Ponce and Mayagüez. Fruits of all sizes and stages of maturity were inspected. Whenever a papaya appeared as tho it might be infested (i. e. showing drops of milk either dried or wet on the surface, or slightly shriveled or turning yellow prematurely) it was cut open and the contents thoroly gone over. No evidence of infestation could be found nor did careful inquiry lead us to suspect that any one had ever seen infested fruits.

The above survey, tho it did not include the Eastern and South Eastern part of the Island, led us to believe that this fruit fly is extremely rare in Porto Rico or possibly entirely absent. However on September 1, 1930 Mr. Sein found at Lares a large overripe papaya fruit which had been purchased locally, to have an exit hole and to contain within a full-grown larva, which pupated September 3, and several other larvae which had been injured by ants. The same day two immature fruits were found underneath a tree near Lares, each containing a number of larvae among the seeds. We proceeded to Lares on September 11 and upon re-examining the same trees as before found 5 fruits infested, out of a total of 30 cut open. The next day we cut open 8 fruits in the market in Mayagüez and found 2 infested.

Thinking that we might have made the survey too early in the season we visited September 25–27, Carolina, Fajardo, Humacao, Patillas, and Guayama as well as both Aguirre and Ponce again. A total of 132 fruits were cut open from many trees and 6 fruits from the market in Ponce. No evidence of infestation was found.

Mr. A. G. Harley, U. S. Plant Quarantine and Control Administration Inspector for the Port of Mayagüez and Prof. Danforth of the College of Agriculture at Mayagüez obtained 3 medium green, infested fruits from their local market on September 20. These contained 8, 3, and 13 larvae respectively, all of which pupated in sand in a glass jar on September 25. On October 14, 9 adults emerged and on the 15, the remaining 4 adults, giving a pupal stage of 19–20 days. Seven adults reared at Lares in September had a pupal period of 20 days.

M. D. LEONARD and F. SEIN, JR., *Insular Experiment Station, Rio Piedras, Puerto Rico*

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ANNUAL SCIENTIFIC MEETINGS: 1931-1932, New Orleans; 1932-1933 Atlantic City.

The Section of Extension in its symposium on the effect of the 1930 drought upon insect population has brought together some very interesting data. These necessarily relate to the immediate and apparent effects and can be used in only a very general way in prognosis. As a matter of fact, the drought conditions of 1929 and 1930 have developed at present, only to what may be considered the immediate effects. There are others which may be expected to become apparent this coming season and even in 1932, and these may be even more far reaching than those already recorded. The symposium of the past meeting should be used as a basis for studies and observations upon this phase of entomology the coming season and also next year. We have altogether too little data in relation to the influence of drought conditions upon insect populations, and almost nothing upon the relation of drought effect upon the abundance of insect pests. The whole matter is an exceedingly complicated one. It has important economic applications, and opportunities such as those to be presented this coming season and the year following should be seized wherever possible. The ability to forecast to even a slight extent probable developments in relation to insect life means very much to economic entomology. We should not be content with obvious remedial measures. We should strive to develop a sound basis for general preventive methods.

The address of the President emphasizes the need for general studies of insect life and by implication at least, raises a question as to whether

this phase of entomology is receiving adequate attention. The general entomologist, the one covering the entire field, is comparatively rare. Yet entomology is not a science which deals exclusively with individual insects, their control and behavior. It is concerned primarily with insects as a group, since no one species is entirely uninfluenced by others in the fauna. More than that, all species react to their environment to a very marked degree. The situation is such as to justify a serious question as to whether, in our deep concern to solve immediate and pressing problems, we are not overlooking the broader phases and possibly missing, through failure to interpret these, the real solution for many of the acute insect problems. It is impossible to control the weather. It is entirely feasible to select sites for an orchard, for example, which will not present conditions favoring maximum reproduction of pear psylla. It is realized, in a general way at least, that artificial changes in the environment are responsible for many insect outbreaks. Is it not possible to go farther and ascertain the possibilities of modifying cultural practices and thus reduce the troubles to a practical minimum? The solution of such problems lies not so much with the specialist as with the general student of insect life in its multitudinous phases.

Reviews

The Plant Quarantine and Control Administration by GUSTAVUS A. WEBER, Service Monograph of the U. S. Government, No. 59, pages I–X, 1–198, The Brookings Institution, Washington, D. C., 1930.

The Bureau of Entomology by GUSTAVUS A. WEBER, Service Monograph of the U. S. Government, No. 60, pages I–XII, 1–177, The Brookings Institution, Washington, D. C., 1930.

These two volumes are comprehensive studies of the Plant Quarantine and Control Administration and the Bureau of Entomology, both of the United States Department of Agriculture. The author has given complete information in regard to the organization, personnel, activities, methods of operation and control, and discussions of the more important phases of the work. There is also a list of the publications and acts applying to each branch of the Service, a comprehensive financial statement and a bibliography.

These two volumes prepared upon the same general plan are invaluable to those interested in the extended and diverse entomological work of the Government. The outlines of activities and details of organization give an excellent idea of the work in progress and afford very suggestive guides for similar work under State agencies or under governmental auspices in other sections of the world.

E. P. FELT

A History of Applied Entomology (Somewhat Annecdotal) by L. O. HOWARD, Smithsonian Miscellaneous Collections, Volume 84, Publication 3065, pages I–VIII, 1–564, 51 plates, Smithsonian Institution, Washington, D. C., 1930.

This volume is very different from the ordinary history of the development of a science. It is a history written by one who has served as a Government Entomologist for more than 50 years and therefore possesses a unique fund of information based upon personal contacts and observations. The author gives in a most attractive manner many details which rarely find their way into print. The work is particularly delightful on account of the well presented human phases of the subject. It is a history in a way of the activities and reactions of many of the author's acquaintances through a long series of years. It has been his good fortune to be associated intimately with the leaders in his chosen science, not only of this country, but in other sections of the world, and the results make an exceedingly readable story.

The early history of economic entomology in the United States is covered rather fully. It is natural that more attention has been given to the work of the Division of Entomology, later the Bureau of Entomology, of the United States Department of Agriculture, since Dr. Howard is more familiar with this. He has not attempted to give a comprehensive survey of the more recent entomological work conducted by state and educational institutions in different sections of the country. One of the charms of this volume are the intimate notes based upon a thorough appreciation of the works of the early entomologists, such as Harris, Glover, Fitch, Walsh, Riley, Comstock and Hagen. The younger entomologists will find in this part of the volume a valuable guide to the study of the earlier literature.

The comprehensive account of the development of economic entomology in Europe and other parts of the world is one of the most valuable sections, because so much of it is based upon personal familiarity over a long series of years. Data are given here which will be of great service to anyone desirous of learning what has been accomplished in various countries.

The discussion of medical entomology, a subject in which Dr. Howard was one of the outstanding leaders, is equally valuable not only because of its historical interest, but also on account of his appraisal of the importance of this phase of economic studies.

Dr. Howard's observations upon biological control are especially timely in view of the present great interest in this phase of the work and the probability that we are even now at the very beginning of developments along this line. His intimate knowledge respecting the utilization of insects for the control of weeds, particularly in Australia, is of more than passing interest. He rightly emphasizes the gratifying progress indicated by the somewhat general recognition at the present time that economic entomologists are scientists with a standing approximating that of research workers in other professional lines. It is easily seen from his summary of the publications on economic entomology appearing in different sections of the world that America holds the lead and that the scientific staff of the present Bureau of Entomology and the Plant Quarantine and Control Administration make very material contributions to the volume of matter put out by American workers.

The 51 plates reproduce photographs of the earlier or leading American entomologists and a very large number of those in other parts of the world. This series of illustrations is a highly appreciated portion of the volume, since all delight in scanning the features of co-workers, particularly those who have gone before or who are located in distant countries.

As a record of human endeavor in one of the newer sciences, this volume occupies a unique place. Approximately 1400 different individuals are noticed in this work and in most instances, there is at least a suggestion as to the part which has been played by each in the development of applied entomology. The work is not a complete history of economic entomology. It is comprehensive in the broader aspects and one which cannot fail to be an inspiration to all interested in entomology and its many economic applications.

E. P. FELT

Thomas Say, Early American Naturalist by HARRY B. WEISS and GRACE M. ZIEGLER, pp. i-xiv, 1-260, 27 illustrations, mostly plate inserts, Charles C. Thomas, Springfield, Illinois, 1931.

The authors have given us a comprehensive, well written account of a man and his reactions to his environment. It is more than a history of a naturalist, interesting though that may be. It is an account of individual achievement unaided by wealth or prestige. It depicts the conditions of that period, 1787 to 1834, as they would affect the enterprising man of moderate means. There is an implied interesting comparison between those times and ours which is of interest to all, and doubly so to the naturalist possessed of a deep sympathy with the struggles of a highly esteemed predecessor. Compare the 67 day trip from Philadelphia to Fort Dearborn with the train service to the Chicago of today or the few hours by air plane. Present day naturalists, even teachers of entomology, take advantage of this latest method of travel.

Say came of a good family. His father recognized his obligations to the community. The subject of this sketch grew up in the very wholesome atmosphere of Philadelphia, a city where culture was highly regarded and wealth not unduly magnified. The period was one of frugality. Say's associates were deeply interested in science. It is more than probable that these conditions had a determining influence upon Say's writings. Clarity and conciseness were at a premium,—a lesson which some of Say's successors might well take to heart.

The trip to Florida and the two with Long's expeditions gave Say an unexampled opportunity to collect and describe an almost unknown fauna. He was primarily a collector and systematist. The trip to Mexico afforded another opportunity to gratify a ruling passion. It appears from the record that his devotion to such pursuits was so great as to compel unwise frugality in living. He thus circumscribed his activities. This was presumably a factor in shortening a notable scientific career.

The brief accounts of Say's life at New Harmony, his friends and associates and his foreign correspondents all add to the human interest of the book. The authors have gone to considerable trouble to obtain data regarding Mrs. Say, the location of the Say manuscripts, the portraits of Say, the partial genealogical record of the family and have published the genealogical records from the Bible of Thomas Say.

There is an interesting account of the Say collections, especially the insects. The specimens suffered from the age old enemies of systematists, dermestids and other

insects, and their condition was not improved by the inevitable greater hazards of transportation in those early days. It is presumably needless to add that all types and noteworthy collections should be deposited in institutions where there is a certainty of adequate curatorial care.

Thomas Say was easily the leading naturalist of his day, entomologist, conchologist and paleontologist. He is the father of American entomology. We recognize in him a master reader of insect structure. His followers should study the works of this master and do likewise.

The volume is an excellent specimen of good printing. The type and illustrations are clear and the make-up most satisfactory.

E. P. FELT

Current Notes

J. J. Davis, entomologist of Purdue University, was elected President of the Indiana State Academy at its annual meeting held at Franklin College, December 5.

Mr. S. W. Frost is spending a month at the Royal Palm State Park, Homestead, Florida, rearing and studying leaf mining insects.

Mr. R. E. Balch, Entomological Branch, returned to the Fredericton N. B., laboratory after having completed an investigation on black-headed budworm and hemlock borer in Nova Scotia.

In November several interesting cases of heavy infestation in Washington, D. C., by the furniture carpet beetle, *Anthrenus vorax*, were brought to the attention of the Bureau.

Spring-tails are proving to be a serious factor in the production of mushrooms in the vicinity of Ottawa and Montreal, and experiments for their control are under way.

Appointments in the Bureau of Entomology have been given to H. A. Mason, Agent, for duty at Columbus, Ohio, and to C. E. Woodworth, Associate Entomologist, for duty at Walla Walla, Wash.

Probationary appointments, Bureau of Entomology have been given to H. A. Waters, Junior Entomologist, for duty at Twin Falls, Idaho, and to R. S. Lehman, Assistant Entomologist, at Walla Walla, Wash.

O. E. Gahm, Bureau of Entomology, who has been engaged in investigations of mushroom pests, resigned October 20 to accept a position with the Chester County Mushroom Laboratory at West Chester, Pa.

Wallace Colman, formerly of the Food, Drug and Insecticide Administration, was appointed Associate Entomologist, Bureau of Entomology, July 21, 1930, and assigned to an investigation of household insects, with headquarters at Sligo, Md.

On December 12, Dwight F. Barnes, Bureau of Entomology, of the Dried-fruit Insect Laboratory, Fresno, California, attended a meeting of the Entomological Club of Southern California, held at the Los Angeles County Museum.

E. P. Venables and A. D. Heriott, of the Dominion entomological laboratory at Vernon, B. C., visited the Bureau of Entomology field laboratory at Wenatchee, Washington, early in October, and conferred with M. A. Yothers, in charge.

W. R. Walton, Senior Entomologist, Bureau of Entomology, returned to Washington, December 15, 1930, from Moorestown, N. J., where, since June 16, last, he had been acting in charge of the Japanese-beetle and Asiatic-beetle investigations.

A film strip, entitled "Preventing Termite Damage, Series 260," is available for distribution by the Office of Cooperative Extension Work, U. S. Department of Agriculture. This film strip, with a 7-page lecture, may be purchased for 35 cents.

A. N. Caudell, Bureau of Entomology, spent the last two weeks of October at the Museum of Comparative Zoology, Harvard University, where he worked with Nathan Banks, Curator of Insects in that museum, on various neuropteroid groups.

Several outbreaks of white grubs, which occurred in eastern Ontario, Canada, necessitated a survey of the infested districts in Stormont and Glengarry counties. The grubs were found to be present in injurious numbers over a wide territory.

Paul W. Oman, a graduate of the University of Kansas, joined the staff of the Bureau of Entomology, as Junior Entomologist on October 10. Mr. Oman will work on the classification and identification of Homoptera, and especially on the Cicadellidae.

T. R. Gardner, Bureau of Entomology, recently returned to the Japanese-Beetle laboratory after four years' work in Japan and Korea, where he has studied the parasites of *Popillia japonica* and made extensive shipments of them to the laboratory.

At the request of Senators Borah and Thomas, of Idaho, Dr. W. H. Larrimer, Bureau of Entomology, made a brief trip, November 4 to November 13, to the Northwest, for the primary purpose of going over the wireworm situation in Idaho.

In the latter part of November George B. Wagner, Bureau of Entomology, of the flourmill insect field laboratory, at Manhattan, Kans., visited milling establishments in and about Minneapolis, Minn., in the course of studies of conditions affecting export flour.

Dr. C. F. Baker, Bureau of Entomology, reached Los Angeles on November 24 from Honolulu, where he spent the preceding three months reorganizing the field laboratory there. After a short stop at the field laboratory at Whittier, California, he returned to Washington.

The Bureau of Entomology research work on the Japanese beetle and Asiatic beetle, with headquarters at Moorestown, N. J., has been put in charge of Charles H. Hadley, who succeeds Loren B. Smith, resigned. Mr. Hadley's appointment was made effective December 16, 1930.

From September 19 to October 14 over 31,000,000 pounds of tobacco were fumigated in the vicinity of Richmond, Va. The fumigation work was conducted under the supervision of W. D. Reed, assisted by Messrs. Cotton, Livingstone, Ellington, and Good, of this division.

Mr. E. B. Watson, Entomological Branch, returned to Ottawa from the North Shore of the St. Lawrence river in Quebec, at the end of September. He reports that the hemlock looper outbreak which was severe in 1928 and 1929, has now completely subsided.

Messrs. Tai Hee Hong and Kam Hu Lau ,were given appointments as agents with the Plant Quarantine and Control Administration, Bureau of Entomology, effective October 8, for duty at Honolulu, where they will be engaged in research work on the Mediterranean fruit fly.

An extensive survey of insect conditions in south-eastern Saskatchewan and south-western Manitoba, particularly in connection with the wheat stem sawfly, was made by Mr. Criddle, Entomological Branch, with the assistance of Mr. P. C. Brown of the Division of Foreign Pests Suppression.

George G. Ainslie, Associate Entomologist, Bureau of Entomology, of the field laboratory at West Lafayette, Ind., died suddenly of heart trouble on Friday night, December 19, while in travel status in Washington, D. C. The remains were taken by Doctor Larrimer to Knoxville, Tennessee, for burial.

C. P. Clausen, Bureau of Entomology, after spending some time in Cuba preparing for another expedition to the Orient to collect additional parasites of the citrus black fly, left Havana on December 22 for the Straits Settlements. En route he will stop at Panama, Honolulu and Manila.

During the late season particular attention was given by the officers of the Entomological Branch stationed at the Lethbridge, Alta, laboratory to a grasshopper survey of the southern half of Alberta. With minor exceptions, nothing has been found that would indicate serious grasshopper trouble in 1931.

F. D. Butcher, Extension Entomologist, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, was appointed December 15, 1931, and M. P. Jones, Extension Entomologist, Ohio State University, Columbus, Ohio, was appointed January 5, 1931, to carry on extension work in economic entomology in cooperation with the Extension Service of the United States Department of Agriculture.

W. F. Sellers, Bureau of Entomology, sailed from New York October 15, for Europe. He will be stationed at the temporary field laboratory at Budapest, Hungary, where he will be associated with P. B. Dowden in the study and the introduction into the New England States of European parasites of the gipsy, brown-tail and satin moths.

Mr. L. W. Brannon, Norfolk, Va., J. R. Douglas, Estancia, N. Mexico, and B. J. Landis, Cuernavaca, Mexico, all members of the Bureau of Entomology Mexican Bean Beetle Project are spending the winter months at the Bean Beetle Laboratory, Columbus, Ohio, completing their reports and preparing manuscripts or completing certain phases of their research work.

On November 7 and 8 Perez Simmons, D. F. Barnes, and A. W. Morrill, jr., Bureau of Entomology, attended the annual Fig Institute held at Exeter, Tulare County, California. Mr. Simmons read a paper entitled "Progress report for 1930 on work with fig insects," and an exhibit prepared at the Dried Fruit Insect Laboratory was displayed and attracted much attention.

Dr. T. E. Snyder, Bureau of Entomology, of the division of forest insects, recently made a survey of termite conditions at Albany, Georgia, at the urgent request of the Chamber of Commerce of that city. While in Albany he visited the pecan-insect laboratory there and conferred with G. F. Moznette concerning the local infestation by termites.

Professor H. J. Quayle, of the University of California was the guest of his sister in Champaign, Illinois, following the convocation meeting in Cleveland. On January 6th he lectured before Hexapoecia, the Entomological Club of the University on the subject, "Around the World with Subtropical Insects." A luncheon and reception were given in his honor by local entomologists.

J. L. Gardiner, a graduate of the Maryland Agricultural College has been appointed Junior Entomologist, Bureau of Entomology and will assist C. B. Nickels in the investigation of pecan insects, with headquarters at Brownwood, Texas. C. C. Pinkney, Junior Entomologist at the field laboratory at Brownwood, has recently resigned to take up studies in landscape architecture at Harvard University.

B. R. Coad, Bureau of Entomology, returned to Tallulah, La., on November 6 from an extended trip to the West. While in the West he conferred with the men in charge of the investigations of the pink bollworm, Thurberia weevil, and cotton leaf perforator, reviewed with them the work of this season, and outlined investigations for the coming year.

Beginning October 30, D. F. Barnes and A. W. Morrill, Jr., Bureau of Entomology, accompanied a representative of a prominent dried-fruit interest on a tour of inspection of raisin plants at Fowler, Selma, Kingsbury, Dinuba, Parlier, and Del Rey, California. The fig moth, *Ephestia cautella*, has assumed a position of major importance as a pest of dried fruits in California.

At the request of the federally owned Inland Waterways Corporation, Dr. R. T. Cotton, Bureau of Entomology, left Washington October 19 for Cairo, Illinois, where he made a study of insect conditions in some wheat belonging to the Federal Farm Board. As a result of the drought, the wheat had been stored in barges stranded in the Mississippi since last July.

A lumber company recently reported the death of pine trees covering a considerable area in the vicinity of Houston, Texas. These trees were believed to be suffering from the effects of drought, and were subsequently attacked by secondary bark-beetles. During the months of June to September, inclusive, there was an accumulative deficiency of 10.59 inches of rainfall in that area.

On November 19 a small shipment of parasites of the birch leafmining sawfly, *Phyllotoma nemorata* Fall., was received at the Gypsy Moth Laboratory, Melrose Highlands, Massachusetts, from P. B. Dowden, of the European gipsy-moth station, at Budapest. This material, apparently consisting of two species of Hymenoptera, and arriving in a dormant condition, had been procured in lightly infested areas in northern Austria.

Dr. Herbert Spencer, formerly with the Louisiana State Experiment Station, at Baton Rouge, has been appointed Entomologist, Bureau of Entomology. His headquarters will be at the field laboratory at Albany, Georgia, where he will make an intensive study of the entire parasite complex relating to pecan insects. A special laboratory for the propagation of *Trichogramma minutum* will shortly be constructed at this station.

Harold R. Yust, Bureau of Entomology, has been given a probationary appointment as Senior Scientific Aid, with headquarters at Whittier, California, to assist in carrying out experiments relating to the resistance to hydrocyanic-acid gas of scale

insects injurious to citrus trees in southern California, and similar problems. Mr. Yust holds the degree of Master of Science from the North Carolina State College.

Conditions in the recreation areas in the region of Lake Tahoe have been the source of a great deal of correspondence and complaints from summer-home owners during the past season. The most serious problem is that due to the fir engraver beetle in white fir. During the season J. M. Miller, Bureau of Entomology, has made several reconnaissance trips in company with Forest Pathologist Wagener.

A. C. Mason, Bureau of Entomology, of the field laboratory at Honolulu, Hawaii, left the Hawaiian Islands on September 17 to spend a few months in the States. He stopped at the field laboratory at Lindsay, California, for consultation with E. A. McGregor, in charge, on problems relating to citrus thrips. He reached Washington on October 31, and has since been preparing manuscripts on previous work, and consulting with Bureau officials.

Dr. R. T. Cotton, Bureau of Entomology, accompanied by J. H. Cox, of the Bureau of Agricultural Economics, was present at Norfolk, Virginia, December 15, when wheat previously fumigated with the ethylene oxide-carbon dioxide mixture was run from the bins. Examinations indicated that the fumigant was very effective, and all parties concerned were highly pleased with his additional demonstration of satisfactory and safe control of weevils in terminal elevators.

C. N. Ainslie, one of the oldest employees of the Bureau of Entomology both as to point of service and accumulation of years, has retired effective October 31, 1930. His long and conscientious service rendered to the Bureau and his valuable contributions to entomology are so well recognized by everyone that they need not be reviewed. Mr. Ainslie will continue to be associated with the Bureau as a Collaborator.

J. A. Beal, Bureau of Entomology, of the field laboratory in Region 6, located at Portland, Oregon, is spending the winter months at the field laboratory at Berkeley, California, where he will carry on laboratory experiments to determine optimum conditions of temperature for development of the brood of the western pine beetle, *Dendroctonus brevicomis*. This detail was arranged because of the special equipment available for this purpose at the University of California.

Persons interested in entomology in Indiana held their annual conference following the Academy of Science meetings at Franklin, Indiana, December 6. Those in attendance included: H. E. Enders, H. O. Deay, G. E. Marshall, J. J. Davis, Thos. Harrison and H. K. Riley of Purdue University; C. F. Adams and A. J. Martin of Indianapolis; A. C. Kinsey, F. Payne, and W. S. Hughes of Indiana University; Merle Wimmer of Center Grove; D. M. Aikins of Franklin; and M. R. Davis of Muncie.

An item of general interest, passed on by Perez Simmons, of Fresno, California, is that one man in California lost 70 sheep this fall when he attempted to "sheep off" the foliage and fruit of a vineyard where Paris green had been used last March against cutworms. The usual method for controlling the climbing cutworms which destroy many grape buds is to place poisoned mash in the crotches of the vines.

Dr. K. A. Salman, Bureau of Entomology has completed a survey, following up numerous letters and reports of forest officers from the San Bernardino and Cleveland National Forests in southern California. A highly epidemic condition of the western pine beetle was found in Coulter pine on areas of the Cleveland Forest. Private

owners in several of the recreational areas are planning to conduct control work this winter in cooperation with State and national forest officers.

G. F. Moznette, Bureau of Entomology, left Albany, Georgia, November 11, on a trip of inspection to the pecan-insect field laboratories at Shreveport, Louisiana, and Brownwood, Texas, where he conferred with the technical workers regarding their projects on pecan insects. While on this trip he attended the Annual Convention of the Oklahoma Pecan Growers Association, held at Duncan, Oklahoma, and presented a paper on the pecan nut case bearer. He returned to Albany, November 25.

An air survey of the Eastern Plumas pine type was made by K. A. Salman and J. M. Miller, Bureau of Entomology on October 8. At the request of the Forest Service a ground survey of this area had been made during the recent summer, and the survey from the air was made as a check to determine whether any important center of infestation has been overlooked; the use of the airplane was authorized by the Forest Service.

The Bureau of Entomology field laboratory at Richfield, Utah, for the study of the beet leafhopper, E. W. Davis, in charge, has been moved to Salt Lake City. This change was made in order to have the laboratory more in the center of the area under survey, so that the ground could be covered in much less time than it would be if the operations were centered in Richfield. The new quarters, at 601 McCormick Building, Salt Lake City, were occupied on November 5.

A study of the life history of the fir engraver beetle and other aspects of the problem, in white fir, was carried on during the recent season by George R. Struble, assisted by P. C. Johnson, both of the Bureau of Entomology. The association of a cambium-killing fungus with the attack of this beetle was pretty definitely established as a result of the season's work, and a number of new points in the life history and habits of the beetle were uncovered.

The Department of Entomology at Purdue University has outlined and is now developing a new course in entomology for pharmacy students which will be given for the first time to the students in the Purdue School of Pharmacy next fall. So far as is known, this is the first entomological course to be offered in any School of Pharmacy. Recently a new course in Forest Entomology was started at Purdue for Forestry students and next fall a new course in greenhouse insects will be offered for Floriculture students.

The field laboratory for the study of forest insects, and associated offices, recently at Stanford University, Palo Alto, California, have been moved and are now established in the new $500,000 building on the campus of the University of California, at Berkeley, which houses the Giannini Foundation. The new location will afford close contact with the California State Experiment Station, the University of California Forestry School, and the educational work of the National Park Service. The shade-tree project, under Dr. H. E. Burke, will remain at Palo Alto for the present.

The fifth annual meeting of the members of the Western Cooperative Oil Spray Project was held at Spokane, Wash., December 11 and 12, under the chairmanship of E. J. Newcomer, Bureau of Entomology. Members from the Agricultural Experiment Stations of Idaho, Montana, Oregon, and Washington, and from the Departments of Agriculture of Canada and of the United States were in attendance.

The current year's work was reviewed, plans were made for the future, and amended suggestions were drawn up for the use of oil sprays. On the afternoon of December 12, representatives of companies manufacturing oil sprays and other insecticides were invited in, and the suggestions were read and were discussed with them.

In the latter part of November, C. B. Wisecup, Bureau of Entomology, of the field laboratory at Sanford, Florida, in company with Dr. F. L. Wellman, of the Bureau of Plant Industry, also stationed at Sanford, made an inspection trip to the Bradentown, Sarasota, and Everglade sections of southern Florida. This was done mainly to gather information as to damage by pests of vegetable crops. Injury by the tomato fruitworm and a mole cricket was found quite prevalent in the vicinity of Plant City, Palmetto and Sarasota. Rather unusual damage by a wireworm was observed in the vicinity of Palmetto on fruit of the pepper plants. Peppers which lay on the ground were fed upon by the wireworms, causing some 5 to 10 per cent injury to the crop.

Reports from Cuba indicate encouraging progress in the development of the natural enemies of the citrus black fly which were imported by Mr. C. P. Clausen, Bureau of Entomology. One, *Eretmocerus serius* Silv. which became established through a shipment sent by him last March, has increased rapidly in numbers at all points of liberation. Very heavy parasitization by this species has been observed in the Malayan region, its native habitat. A coccinellid, a species of Cryptognatha, is now being reared for distribution; it is predacious upon the eggs and early stages of the larvae of the citrus black fly. In shipping these parasites from the Orient, a modified type of Wardian case has been used to permit of continuous breeding of both host and parasites, and while in transit they were carried on the open deck. As a result, the material remained in excellent condition during the six weeks in transit.

The latter part of September was spent by J. C. Evenden, Bureau of Entomology, in charge of the field laboratory at Coeur d'Alene, Idaho, C. B. Morse, Assistant Regional Forester, R-4, and Supervisor Stoddard, of the Targhee National Forest, in checking over the results of the control operations in 1930 directed against an epidemic of the mountain pine beetle in the lodgepole pine forests thereabout. After his return from the Targhee, Teton and Wyoming Forests, Mr. Evenden spent the first few days of October in helping the officers of the Madison National Forest Institute in a survey of a reported outbreak of the mountain pine beetle in the lodgepole pine stand of that forest, and plan for control work in 1931. The week of October 6 to 11 was spent by Mr. Evenden in Glacier National Park, where he assisted in the institution of a project for the control of an epidemic of the Douglas fir beetle (*Dendroctonus pseudotsugae* Hopk.) in the Douglas fir forests of that park.

The sixty-seventh annual meeting of the Entomological Society of Ontario was held at Ottawa in the Chateau Laurier Hotel, November 6–8. The local committee in charge of arrangements consisted of Mr. Arthur Gibson, Chairman, Mr. H. G. Crawford, Secretary, and Messrs. W. N. Keenan and C. R. Twinn. Other members of the Entomological Branch present included Messrs. J. M. Swaine, L. S. McLaine, K. E. Schedl, J. A. Hall, G. M. Stirrett, H. F. Hudson, A. G. Dustan, A. Kelsall, C. W. Smith, A. B. Baird, W. St. G. Ryan, C. B. Hutchings, W. A. Fowler, N. Beaudoin, L. J. Briand, M. B. Dunn, E. B. Watson, A. R. Graham, S. H. Short, A. A. Wood, P. N. Vroom, L. L. Reed, R. H. Painter, C. S. Thompson, C. E. Petch, W. N. Keenan, R. W. Sheppard, G. H. Hammond, G. S. Walley, T. Rankin, J. J. deGryse and L. Deviault. The programme was a full and interesting one, more than fifty papers

being presented by members of the Society and other entomological workers. Dr. James G. Needham of Cornell University, was a guest speaker and gave an address on "War, a Biological Phenomenon" on the evening of November 6. The members of the society and their friends were entertained as the guests of the officers of the Branch at a Smoker on the evening of November 7. At the smoker, Mr. Frank Morris gave an entertaining talk on the subject of "An Entomologist in Algonquin," and Mr. T. Wayling spoke on the subject of "Across the Atlantic in the R-100."

The eighth annual meeting of the Entomological Society of Pennsylvania was held at Harrisburg, Pa., on January 20 in conjunction with the State Farm Products Show. The program consisted of informal talks by members on the following subjects: The effect of drought on Hessian fly abundance, C. C. Hill; Apple spraying in Pennsylvania, H. E. Hodgkiss; Mushroom insects and their control, C. A. Thomas; Insect problems in our Pennsylvania forests, J. N. Knull; What we look for in nursery inspection, F. M. Trimble; Parasites of the Japanese beetle, C. H. Hadley; The Japanese beetle in Pennsylvania in 1930, R. H. Bell; The present status of the European corn borer in Pennsylvania, T. L. Guyton; Recent research on the European corn borer in Pennsylvania, H. N. Worthley; The status of the Oriental fruit moth and its parasites in Pennsylvania in 1930, J. O. Pepper. After dinner Mr. Leo A. Luttringer of the State Game Commission talked of the wild life of Pennsylvania, as revealed by the motion picture camera. The pictures, most of which had been taken by Mr. Luttringer, were most interesting and unusual. The following were present: E. J. Anderson, P. T. Barnes, R. H. Bell, A. B. Champlain, M. W. Eddy, H. J. Fisher, F. S. Foster, T. L. Guyton, C. H. Hadley, W. T. Henery, C. C. Hill, H. E. Hodgkiss, F. L. Holdridge, J. N. Knull, W. H. Larrimer, W. B. Mabee, J. O. Pepper, P. D. Peterson, W. E. Phillips, J. S. Pinckney, G. E. Sanders, G. B. Sleesman, J. R. Stear, G. B. Stichter, C. A. Thomas, F. M. Trimble, E. J. Udine, H. N. Worthley.

Horticultural Inspection Notes

Mr. J. E. McDonald has been appointed Commissioner of Agriculture of Texas, succeeding Mr. George B. Terrell.

Mr. John A. Maney, who was connected with the New York Department of Agriculture and Markets, as a nursery inspector, died in July, 1930.

The Plant Quarantine and Control Administration has recently issued summaries of the plant quarantine restrictions of Germany (PQCA-302), and of France (PQCA-301).

The Federal satin moth quarantine has been amended, effective February 1, 1931, adding considerable territory in the New England States, mostly in Maine, to the regulated area.

Messrs. Otto H. Richter and A. L. Pillar have been appointed by the Wisconsin Department of Agriculture and Markets to assist in nursery inspection work in that State during the coming summer.

An informal conference concerning the phony peach disease situation is to be held in the Biltmore Hotel, Atlanta, Ga., on February 4, during the meetings of the Southern Agricultural Workers in that city.

According to a report from the State Entomologist's Office of Minnesota, the elm gall midge *Phytophaga* sp. has caused considerable trouble in some parts of that State this year, attacking the terminal growth of young elms.

Dr. I. T. Scott and Mr. Charles Denny have recently been employed by the Plant Division of the Missouri State Board of Agriculture as pathologist and entomologist respectively, to assist in the inspection of nursery stock in Missouri.

Messrs. Herman Breitfeld and L. Arthur Gilbert have been appointed during the past year as nursery inspectors for the Department of Agriculture and Markets of New York State and have been assigned to duty in the Geneva and Long Island districts respectively.

Mr. Ernesto Sanchez Estrada, in charge of the plant quarantine work of the Republic of Cuba, spent a week early in January at Washington, conferring with members of the Plant Quarantine and Control Administration regarding port inspection and domestic quarantine enforcement.

Mr. M. S. Yeomans, State Entomologist of Georgia, made a trip to the Pacific Coast the latter part of December, visiting a number of plant quarantine stations en route and conferring with members of the State and Federal departments of agriculture regarding plant inspection and quarantine methods.

Vincent F. Peterson, a deputy nursery inspector of Minnesota, has accepted a temporary position effective December 8th as Plant Pathologist for the Roessler and Hasslacher Chemical Company of New York City, with headquarters at St. Paul. Mr. Peterson's territory covers Minnesota, North and South Dakota and Montana.

Our word quarantine, from the Italian word for forty, harks back to the Middle Ages, when plague sufferers were isolated for forty days, that precise period being chosen because it was the duration of Christ's lonely stay in the desert, and not for any scientific reason. (*Exchange.*)

The requirement of fumigation of cotton lint and linters produced and ginned in Chaves County, New Mexico, has been reinstated by the United States Department of Agriculture as a condition for the interstate movement of such lint to points outside the regulated area of New Mexico. The reason for this change is the discovery of living pink bollworm larvae at Hagerman, New Mexico.

The California Department of Agriculture has revoked Quarantine Circular No. 7, pertaining to the navel orange worm, and Pest Control Regulation No. 4, pertaining to strawberry root weevils. Action concerning the orange worm is based on determination by the Department that it "is an insect of no economic importance" and the cancelling of the strawberry root weevil quarantine is based on findings that these weevils "are generally distributed in many localities in and throughout the State of California."

A conference to review the pest situation with respect to the foreign importation and interstate movement of narcissus bulbs, called by Mr. Lee A. Strong, Chief of the Plant Quarantine and Control Administration, was held in the Auditorium of the National Museum, Washington, D. C., on January 29. The notice announcing the conference stated that it was to be held "for the purpose of reviewing the entire situation with a view to promptly determining whether the present restrictions are necessary for the protection of American agriculture and horticulture from pests."

Mr. C. H. Hadley, who has been in charge of the enforcement of the Japanese beetle quarantine regulations with headquarters at Camden, N. J., was transferred at his own request in December to assume direction of the investigational work of the Bureau of Entomology relating to this insect. His new headquarters will be in Moorestown, N. J. The Japanese beetle control work of the Plant Quarantine and Control Administration has been assigned to Mr. L. H. Worthley, who will be responsible for carrying out the field work as to both the Japanese beetle and European corn borer quarantine projects.

The Arizona State Commission of Agriculture and Horticulture on December 16, 1930, promulgated an order declaring considerable areas of Maricopa, Pinal and Pima counties as areas regulated to control or eradicate the pink bollworm. The restrictions placed in effect as to these areas prohibit the growing of stub cotton, and the planting of upland cotton prior to April 20 or of Pima cotton prior to April 1, and require the thorough cleaning of all cotton fields not later than February 1, and the plowing of such fields prior to February 15. The points covered are based on pink bollworm findings during the past fall at several new localities outside the sections previously known to be infested in the Salt River valley.

Under a revision of the Federal European corn borer quarantine regulations, the two-generation area is extended to include New York City, Long Island, and adjacent sections of New York, New Jersey, and Connecticut. Several changes are also made in the restrictions affecting the interstate movement of ear corn and beans. Since the one-generation strain of the borer has already reached the two-generation area in Massachusetts and New Hampshire, the department announces that no further attempts will be made to retard the spread of this strain into New England. Accordingly, all restrictions are removed on the shipment of ear corn from the one-generation area to the two-generation area where the areas are contiguous in New England and New York.

Mr. J. D. Winter, Assistant State Entomologist of Minnesota, reports that the total number of nursery premises inspected during 1930 in Minnesota was 397, a total of 546 inspections being made. Nineteen of these premises were refused a certificate of inspection. In addition, 61 storage cellar inspections were made and 110 inspections of nursery stock on the premises of dealers. One firm was prosecuted and conviction secured for the sale of uninspected nursery stock. Minnesota has approximately 4,185 acres planted to nursery stock. One Minnesota nursery has more than 100 acres of red raspberries. This is probably the largest planting of red raspberries in the United States grown exclusively for the sale of plants. No fruit is sold from this planting. During 1930 State inspectors examined 6,513 packages of nursery stock in transit by express and freight. Forty-four packages without a valid certificate were intercepted, nine of these packages being returned to the sender.

Apicultural Notes

George E. Marvin, Instructor in Apiculture at the University of Wisconsin, has been appointed Assistant Apiculturist, and will report for duty at the Bee Culture Laboratory, at Somerset, Md., in January.

J. E. Eckert, Associate Apiculturist, Bureau of Entomology, at the Intermountain Bee Culture Field Laboratory, Laramie, Wyoming, has been granted leave of absence to enable him to continue graduate work at the Ohio State University, at Columbu's which he is now pursuing.

The Alabama Beekeepers' Association held their annual meeting in Montgomery, November 7th and 8th, 1930. The meeting was well attended, with Dr. E. F. Phillips of Cornell University the honor guest of the Association. He discussed subjects of importance to the commercial beekeepers. Dr. Warren Whitcomb, Jr., of the Southern Regional Beekeeping Research Laboratory, Baton Rouge, La., represented the U. S. Bureau of Entomology at the meeting.

Prof. H. F. Wilson, Custodian of the C. C. Miller Memorial Library, at Madison, Wisconsin, very generously gave to the library of the Bee Culture Laboratory the title-page and index for Volume 9 (1873) of the American Bee Journal, one of the rare volumes of this journal. The acquisition of this material completes the file of the American Bee Journal in the library of the Bee Culture Laboratory.

The second paragraph of a statement issued by Secretary Hyde on December 26, 1930, is of particular interest to beekeepers. In giving the status of corn sugar under the Federal food and drugs act it is stated that "The use of pure refined corn sugar as an ingredient in the packing, preparation or processing of any article of food in which sugar is a recognized element need not be declared upon the label of any such product." Furthermore, "Nothing in this ruling shall be construed to permit the adulteration or imitation of any natural product such as honey by the addition of any sugar or other ingredient whatever."

Notes on Medical Entomology

Harold S. Peters, Bureau of Entomology, spent the last week of November in Central Pennsylvania with officers of the Pennsylvania Game Commission, investigating insect parasites of white-tail deer.

D. G. Hall, Bureau of Entomology, was transferred November 4 from the investigations of the eye gnat in Coachella, California, to Charleston, S. C., where he will assist Dr. W. E. Dove in work on the sand fly.

J. L. Webb, Bureau of Entomology, left Washington on November 15 for Ames and other places in Iowa, for a few weeks' cooperative work with the Iowa Experiment Station and Extension Service on the problem of the horse bots.

F. C. Krueger, Bureau of Entomology, who has been employed at the sand-fly field laboratory at Charleston, S. C., as temporary field assistant, has been given an appointment as Senior Scientific Aid, effective December 27, for duty at Charleston.

On December 1 and 2, in New York, F. C. Bishopp, Bureau of Entomology, attended the Seventeenth annual game conference held under the auspices of the

American Game Protective Association. The question of ectoparasites of game birds and animals was discussed with various research workers and administrators.

On December 10 W. G. Bruce, Bureau of Entomology, in the course of an investigation of ticks in connection with relapsing fever, collected several ticks in a cave near Roanoke, Denton County, Texas. Several ticks became attached to his person. Some eight days later he developed a well-defined case of relapsing fever.

Dr. W. V. King arrived in Yokohama, Japan, on November 1, en route to Manila, Philippine Islands. Doctor King is on a year's leave of absence from the Bureau of Entomology to make intensive studies of the Anopheles mosquitoes of the Philippine Islands, under the auspices of the International Health Division of the Rockefeller Foundation. This work was begun by Doctor King during a six month's leave of absence in 1928–29, and he expects on the present assignment to clear up, at least in large part, the specific identity and biological relationships of the more important Anopheles of the Philippine Islands.

Since his return on October 1 from a trip of three and one-half months through the southern Bahama Islands, many islands surrounding Cuba, and the Isle of Pines, Harold S. Peters, Bureau of Entomology, has been engaged largely in compiling his notes and caring for the material collected on the trip. Mr. Peters accompanied the West Indian Expedition headed by Dr. Paul Bartsch, of the National Museum. He devoted special attention to the collection of ectoparasites of birds and to a study of the situation as to the sand fly on the islands visited. A large collection of Mallophaga was made, and accurate host and distribution records were obtained.